Chapter 2 Alternatives

Chapter 2 presents the alternatives being considered in this EIS for the cost-effective reduction of potentially harmful effects of the Hawaii-based longline fishery on short-tailed albatross and seabirds generally, and for management of the U.S. Pacific Ocean squid jigging fisheries. Separate sets of alternatives were developed for the two independent management objectives described in Chapter 1. Section 2.1 describes the development and evaluation of the seabird action alternatives, and Section 2.2 describes the alternatives for management of the Pacific Ocean pelagic squid jigging fisheries.

2.1 Seabird Action Alternatives

This section first describes the strategies available to achieve the seabird action objective and provides a rationale for selection of the strategy adopted. It then explains the qualitative and quantitative criteria that are used to evaluate and compare seabird interaction avoidance measures and combinations of measures that might be assembled into action alternatives. Then, in a step-wise fashion, individual seabird interaction avoidance measures, combinations of measures, and finally the action alternatives themselves are described and evaluated using those criteria.

2.1.1 Strategies to Accomplish the Seabird Action Objective

Implicit in the Council's seabird action objective is the desire to cost-effectively minimize adverse effects of longline-seabird interactions on populations of short-tailed albatross and other seabirds, especially albatrosses. There are two potential strategies that could be employed to reduce the harmful effects of longline-seabird interactions on seabird populations: a) reduce the number of interactions, and b) reduce the consequences of such interactions.

<u>2.1.1.1 Reduce Frequency of Longline-Seabird Interactions</u>

The number of longline-seabird interactions may be reduced either by reducing the number of hooks deployed (i.e., reducing fishing effort) or by reducing the number of interactions per unit effort (i.e., reducing the interaction rate). Reduction of fishing effort would reduce landings and therefore reduce fleet revenues. This would not support the action objective of cost-effective reduction of harmful effects to seabirds, and is not a strategy favored by the Council. Reduction of the interaction rate between longlines and seabirds however, may be accomplished in a number of cost-effective ways, and this is the strategy adopted in developing alternatives for analysis in this EIS. Adoption of this strategy is bolstered by the large amount of work that has been done in recent years to develop and test methods to inhibit such interactions. The impetus for the seabird action is rooted in experimentation to reduce interaction rates by fishermen, non-governmental organizations and government agencies in the U.S. and abroad to develop such methods as side-setting and underwater setting chutes. The potential effects of this strategy are of a magnitude sufficient to influence albatross population trajectories. Furthermore, if cost-effective seabird interaction avoidance measures are found to have a positive effect on the efficiency of fishing operations or the catch-per-unit-effort (CPUE) of target species, adoption by other fleets may have additional positive effects on seabird populations.

2.1.1.2 Reduce Consequences of Longline-Seabird Interactions

Birds hooked while longlines are being set (the majority of interactions) have a very high probability of mortality. Birds hooked while longlines are being retrieved may be released alive, but their injuries may result in delayed mortality. It is possible that birds retrieved alive could be given first aid (antibiotics, etc.) or longer-term care before release. This could reduce the consequences of some interactions (i.e., increase post-hooking survival rates), but would require training of personnel, purchase of supplies and diversion of labor from the primary fishing activity. In any event, the majority of interactions occur during setting of the longline and result in unavoidable mortalities, so this strategy has inherent limitations.

Current regulations pertaining to the Hawaii-based longline fleet already serve to reduce the consequences of longline seabird interactions to some extent. Two measures, seabird handling techniques and protected species workshops, are required. It is anticipated that these two measures will continue to be required in this fishery, but they are not affected by any of the alternatives considered in this EIS. The two measures are described below.

2.1.1.2.1 Seabird Handling Techniques

Guidelines for handling hooked seabirds in a manner that maximizes the probability of their long-term survival are provided in the Protected Species Workshops required of vessel owners and operators. Vessel operators are instructed that when a bird is hooked, the vessel should be stopped to release tension on the line and the bird lifted on board with a long-handled dip net. Birds should be covered with clean towels or blankets to protect the feathers from oil or mechanical damage during handling. Trailing line and hooks should be carefully removed, if possible cutting off the hook tip with bolt cutters before removing the remainder of the hook. Deeply ingested hooks are more problematic, and may not be possible to remove.

The 2004 BiOp for the shallow-set sector of the Hawaii longline fishery (USFWS 2004) contains specific instructions on procedures to be followed in the event a short-tailed albatross is hooked. If a short-tailed albatross is hooked and recovered alive, it must be retained unless it exhibits all of the following traits:

1. Head is held erect and bird responds to noise and motion stimuli;
2. Bird breathes without noise;
3. Both wings can flap and retract to normal folded position on back;
4. Bird can stand on both feet with toes pointed in the proper direction (forward); and
5. No evidence of hooks, lines, or wounds on birds with the exception of those areas where hooks or lines have been removed prior to release.

If a dead short-tailed albatross is brought on board, the vessel operator is required to contact NMFS immediately. If a live short-tailed albatross is brought on board, the vessel operator is required to complete an observation checklist, as given in the BiOp (USFWS 2004), and attempt contact with specified veterinarians and seabird experts.

Monitoring compliance with the use of proper handling measures on longline sets is very difficult in the absence of an observer. Vessels can be checked for the presence of required tools by being boarded at sea or during dockside inspections, but this does not ensure that the required measures are followed when necessary. The equipment required for careful handling of seabirds, including bolt cutters, pliers, knife, long-handled dip net, is all either required by current turtle mitigation regulations or routinely carried aboard fishing vessels. Initial costs would be on the order of $100.

2.1.1.2.2 Protected Species Workshops

Hawaii-based longline vessel owners and operators are required to attend annual workshops at PIRO where various protected species issues are discussed. Seabird identification, life history, distribution and interaction avoidance measures are described and a video on handling techniques is shown. Sea turtle biology, species identification and mitigation regulations are also covered as is marine mammal species identification, gear disentanglement and the Marine Mammal Authorization Program. Workbooks containing current regulations, species guides and informational placards are distributed to workshop participants. Operators are required to have on board a current certificate of workshop completion. Enforcement is easily accomplished during at sea or in dockside boardings, and PIRO can cross-reference lists of permit holders and workshop attendees. There are no direct costs to participants, but labor hours that could be used for other purposes are consumed.

2.1.2 Criteria for Alternatives Evaluation

In evaluating how well the individual seabird interaction avoidance measures and the alternatives, most of which contain more than one such measure, accomplish the action objective, both qualitative and quantitative criteria were used. These criteria are introduced below.

2.1.2.1 Qualitative Criteria

Two qualitative criteria were identified as critical to the successful implementation of seabird interaction avoidance measures: operational characteristics and compliance. Operational characteristics include such things as ease of implementation by crew, consistency of performance across a range of variables including time of day, location, weather, sea state, and seabird density, and effect on target species CPUE. Compliance is a measure of the likelihood of a measure's proper use, the likelihood of its use in the absence of observers, and the relative ease with which it may be enforced.

2.1.2.2 Quantitative Criteria

Two quantitative criteria were also evaluated: efficacy of a measure or combination of measures to deter seabirds from baited hooks and the cost of implementation. Each of the measures evaluated in this EIS has demonstrated a high level of efficacy in keeping seabirds from baited hooks, but there are some notable differences among measures. It should be kept in mind however, that the efficacy values were derived from experiments that varied in design and data collection procedures, and consequently the efficacy values are not strictly comparable across measures. The comparative analyses of the alternatives in Chapter 4 use the best available efficacy values for the measures, but acknowledge the differences in their derivations.

Combinations of measures generally can be expected to have greater efficacy than the component measures alone. A possible exception to this generalization is the combination of strategic offal discard with measures intended to hide baits from seabirds. Strategic offal discard, as explained in more detail below, may act to attract birds, off-setting to some degree the avoidance efficacies of measures such as thawed, blue-dyed bait. There are no quantitative data with which to estimate this possible antagonistic effect. In the analyses presented in Chapter 4, it is assumed that the efficacy of strategic offal discard is additive with those of other measures with which it is combined. The rationale for this is that strategic offal discard does not require continuous discharges during a set or haul, which would tend to entice the birds to follow the vessel. Rather a discrete quantity of offal is discarded and then left increasingly farther behind the vessel as it moves away. This being the case, it is assumed that strategic offal discard would not counteract the efficacy of other measures.

The cost criterion includes both initial costs to fishermen to purchase and install gear, and also recurring costs for supplies or maintenance. Cost comparisons of the alternatives are based on total costs to the fleet, but individual vessel characteristics may result in disproportionate costs to some vessels.

2.1.3 Measures Considered to Reduce Longline-Seabird Interactions

There are a number of methods that have been developed by fishermen and scientists that are aimed at reducing longline-seabird (primarily albatross) interactions. Prior to 1991, fishing masters had tried towing buoys, throwing explosives, towing artificial lures and adding weights to sink baits faster (Brothers 1991). In 1991, Brothers had a fishing master deploy a diversion steamer line (tori line) and found that it reduced bait loss to birds by 69% (Brothers 1991). Since then additional seabird interaction avoidance methods have been invented (Alexander et al. 1997, Brothers et al. 1999a, 1999b, McNamara et al. 1999, Boggs 2001, Melvin et al. 2001, Gilman et al. 2003). All seabird interaction avoidance methods, regardless of the details of their design or implementation methodologies, attempt to do one of the following in order to keep seabirds away from baits:

- Make baits difficult for birds to detect;
- Make baits difficult for birds to reach;
- Frighten, physically deter or draw birds away from baits; and
- Reduce the number of birds congregating around the fishing vessel.

In formulating alternatives for assessment in this EIS, first, the characteristics of individual methods that could effect reductions of longline-seabird interaction rates were evaluated. The methods evaluated included those that were specified by the USFWS in its current Biological Opinions (BiOp) on effects on short-tailed albatross of the deep and shallow-set sectors of the fishery (USFWS 2002, 2004a), including thawed, blue-dyed bait, strategic offal discard, using a line-shooter with weighted branch lines and setting lines at night. In addition, an important factor in the Council's decision to initiate this action is that newly developed seabird interaction avoidance measures and measures used in other fisheries elsewhere may also be effective in the

Hawaii longline fishery. Specifically, bird-scaring streamer lines (tori lines) have proven to be effective in deterring seabirds from approaching baited hooks in other longline fisheries, and two measures have shown promise in reducing interaction rates in limited testing in the Hawaii longline fishery. These two measures are intended to make it difficult for birds to reach baited hooks. The first of these is the underwater setting chute. In this measure, baited hooks are deployed through a metal chute at depths beyond the diving capabilities of the seabirds. The second measure is side-setting. This measure requires reconfiguration of deck gear such that the longline is deployed from the side of the vessel rather than from the stern. The baited hooks sink to depths beyond the reach of seabirds by the time the vessel passes the hook. Characteristics of tori lines, underwater setting chutes and side-setting were evaluated and they are all included in alternatives assessed in this EIS.

The following sections review the qualitative and quantitative characteristics of each of the above measures. After evaluation of the characteristics of individual measures, measures were evaluated in combination to determine if there were combinations of measures that worked substantially better than a single measure alone. Following that, a wide variety of alternatives were examined. These alternatives are generally of the form where vessels may use the current suite of measures required by regulations implementing the current BiOps (USFWS 2002, 2004a) or one of the individual methods above, but alternatives are offered which also consider requiring side-setting of all vessels in the fleet and eliminating thawed, blue-dyed bait and strategic offal discard from the default suite of measures.

2.1.3.1 Thawed, Blue-dyed Bait

Operational characteristics

Blue-dyed bait and thawed bait are actually two interaction avoidance measures that could be evaluated or implemented independently. Blue dye makes bait more difficult for birds to detect, and thawed bait sinks faster, thus more rapidly removing it from the reach of seabirds. In practice it is necessary to thaw or at least partially thaw bait for it to take up the blue dye, and current regulations require the use of completely thawed and blue-dyed bait when longlining north of 23°N latitude. Thawed, blue-dyed squid and fish were used in interaction avoidance efficacy experiments conducted in Hawaii using longline gear and methods typical of the fleet. For these reasons these two measures are combined here. In practice, blue-dying bait has its operational drawbacks. Pre-dyed blue bait is not commercially available, requiring fishermen to dye the bait blue as it is thawed before each set. The use of blue dye is messy, dyeing the hands and clothes of the crew and the deck of the vessel. The use of blue dye also requires the crew to deploy the baited hooks away from the propeller wash, where the white water makes the blue-dyed bait more apparent to seabirds. Crews untrained or unfamiliar with the use of blue-dyed bait may reduce its effectiveness by not deploying baited hooks away from the propeller wash. In addition, the prop wash buoys the bait and retards its sinking. Brothers et al. (1999) found that thawed baits sink faster than frozen baits, but thawed bait falls off the hook more readily than firmer, partially frozen bait. Gilman et al. (2003) found that “blue-dyed bait resulted in a relatively low fishing efficiency based on bait retention and hook setting rates.”

Compliance

Monitoring compliance with the use of blue-dyed bait is very difficult in the absence of an observer. Vessels can be checked for tins of blue bait by being boarded at sea or during dockside inspections (a minimum of two, one lb cans are required to be on board), but this does not ensure that the dye is being used, or used properly. However, Gilman (2004) found, in analyzing PIRO observer data from sets made in 2003 and 2004, that the compliance rate on observed trips was 99%. The compliance rate on unobserved trips is unknown, but Gilman also found that some vessels were voluntarily using thawed, blue-dyed bait on sets south of 23°N latitude.

Efficacy
Blue dye has been shown to be effective at reducing seabird interactions when used with squid bait, which readily absorbs the dye, and thus disguises the bait on immersion in the sea. For example, McNamara et al. (1999) in tests using Hawaii longline shallow-set (swordfish) gear reported a 77% reduction in gear contacts and a 95% reduction in bird capture rates using blue-dyed squid bait. The shallow-set component of the Hawaii longline fleet formerly used squid for bait, but is now required to use mackerel-type bait, as has been used by the deep-set (tuna) sector of the fishery. Blue dye is taken up less readily by fish baits such as sanma or sardines (see below), and fishermen report difficulty in achieving the desired intensity of blue color as specified in the regulations, due to the shedding of the deciduous scales of the commonly used bait fish. Gilman et al. (2003) tested thawed, blue-dyed fish bait with Hawaii tuna longline gear and found a 63% reduction in bird capture. While not as good an interaction avoidance measure as blue-dyed squid, blue-dyed fish still has substantial interaction avoidance properties.

Recently, Gilman (2005) analyzed data from the Hawaii longline observer program to assess differences in seabird capture rates by vessels targeting tuna. Sets using blue-dyed fish bait were compared with sets using untreated bait, and sets using 45 g swivels were compared to sets using 60 g swivels. There were no significant differences in seabird capture rates in either comparison based on overlapping nonparametric 95% confidence intervals derived from percentile method bootstrapping at N=1000. However, Gilman cautioned that the confidence intervals may be inaccurate because of the relatively few observed seabird captures, and that the observer database did not provide consistent, reliable information on albatross presence or abundance during setting, preventing conclusions from being made with any confidence.

The use of blue dye to minimize interactions with seabirds has been investigated in New Zealand, and Japan (Eric Gilman, Blue Ocean Institute, personal communication). Information on the performance of blue-dyed bait in the New Zealand tuna fishery (Greg Lydon, New Zealand Seafood Industry, personal communication to Holly Freifeld, USFWS Honolulu) suggests that sanma is better at absorbing blue dye than sardines, but at-sea trials with blue bait have only included squid bait. Results from Japanese fishing trials with blue-dyed mackerel bait (Minami and Kiyota 2002) indicated that blue-dyed bait eliminated seabird captures entirely when used on longliners targeting southern bluefin tuna.

Cost
There is a cost of about $14.00/set (Gilman et al. 2003) associated with dyeing bait blue in the Hawaii longline fishery. Over the period of a year, a vessel might be expected to make 100 sets, amounting to an annual blue dye cost of $1,400 per vessel.

2.1.3.2 Strategic Offal Discard

Operational characteristics
Current regulations require that offal (stored between sets) be discharged (without hooks) while setting or hauling gear, on the opposite side of the vessel from where the longline gear is being set or hauled. Swordfish heads must be removed, and without bills, cut in half vertically before discharge. Livers must be removed and discharged. Until recently, offal discards were easier to implement on vessels targeting swordfish than tuna, because the carcasses of swordfish are headed and gutted before being packed on ice in the vessel's hold. A supply of offal is therefore routinely generated for the next set. On most tuna-targeting longliners however, tuna were not dressed like swordfish. Only the fins and tails were removed before icing, making accumulation of offal for the next set more problematic. Recently however, Hawaii-based tuna vessels have begun to gill and gut their catch at sea, making a supply of offal more readily available for these vessels (B. Takenaka, United Fishing Agency, pers. comm.).

Compliance
Monitoring of compliance with a requirement for strategic offal discards on longline sets, as for the use of blue-dyed bait, is very difficult in the absence of an observer. Fishermen may voluntarily use this measure as it has been shown to be effective and has no cost associated with it. Gilman (2004), in his analysis of recent Hawaii longline observer data, found that only 18% of tuna-targeting sets employed strategic offal discard.

Efficacy
Offal discards have been shown to be effective in reducing interactions with longlines during the period when lines are set. Offal discards were shown to reduce gear contacts by 51% and captures by 86% in tests by McNamara et al. (1999) with Hawaii longline swordfish gear. However, there are also mixed evaluations of the effectiveness of strategic offal discharge (Cherel et al. 1996, Brothers 1995 and 1996, McNamara et al. 1999). Although discharging offal and fish bycatch during setting can distract birds from baited hooks (Cherel and Weimerskirch 1995, Cherel et al. 1996, McNamara et al. 1999), this practice is believed to have the disadvantage of attracting birds to the vicinity of the vessel, increasing bird abundance, searching intensity, and capture (Brothers et al. 1999a). In the long-term, strategic offal discharge may reinforce the association that birds make with specific longline vessels being a source of food. Brothers (1996) hypothesizes that seabirds learn to recognize by smell specific vessels that provide a source of food, implying that vessels that consistently discharge offal and fish bycatch will have higher seabird abundance and capture rates than vessels that do not discharge offal and fish waste.

Cost
There are no financial costs associated with strategic offal discards other than the need to purchase containers in which to store the offal. The cost for containers is estimated at $150 per vessel.

2.1.3.3 Line-shooter with Weighted Branch Lines

Operational characteristics
Line-shooters and weighted branch lines are two separate seabird interaction avoidance measures that could be (and have been) evaluated independently. Because they are linked in current regulations applicable to the deep-setting sector of the fleet, they are considered together here. Although line-shooters and weighted branch lines (minimum 45 g) are required to be used to target deep swimming tuna by Hawaii-based longline vessels, they would likely be used routinely anyway to get the baits deep quickly. Line-shooters function to deploy the longline at a rate faster than that of the vessel, thus creating slack in the line, allowing it to sink without tension. Weighted branch lines serve to sink the baits themselves, which could otherwise linger near the surface until slack is taken up by the sinking main line. Weighted branch lines, however, can be dangerous to crew. When attempting to haul in a live fish, the hook can pull loose or the leader can break, slinging the weight and/or the hook directly towards the fisherman's face. The heavier the weight, the greater the danger. There is anecdotal evidence of serious injuries from 60 g weights, although many operators do prefer the heavier weights. As much as 70% of the Hawaii-based fleet now uses the heavier weights (Sean Martin, Hawaii Longline Association [HLA], pers. comm.). Many operators also now fasten the hook to a section of steel leader to minimize cutting of the monofilament branch line, especially common with hooked sharks (Sean Martin, HLA, pers. comm.). Vessels targeting tuna in the Hawaii-based fleet universally employ line-shooters, except for one vessel which used traditional tarred rope basket gear, but which has since left the fleet. Line-shooters are not needed when setting shallow for swordfish, however, many vessels in the fleet re-rigged from swordfish fishing to tuna fishing after the 2001 ban on shallow-setting in the fleet. These vessels now have line-shooters, and may continue to use them, albeit somewhat differently than deep-setting vessels. Whereas deep-setting vessels deploy the main line at a speed faster than that of the vessel to allow it to rapidly sink, shallow-setting vessels may deploy the line at the same speed as the vessel, intending that it remain relatively shallow. Use in this manner would negate the equipment's seabird interaction avoidance benefits.

Compliance
As noted above, a line-shooter and weighted branch lines are standard gear for targeting tuna in the Hawaii-based fleet, and therefore vessels targeting tuna north of 23°N latitude are automatically complying with this aspect of current regulations. Swordfish-targeting vessels are not required by current regulations to employ line setters or weighted branch lines.

Efficacy
Boggs (2001) found that adding 60 g of weight to branch lines reduced albatross interactions by 92%. Albatross are surface feeders and do not dive as deeply as plunge divers such as boobies. Baits deeper than a few meters are out of reach of albatrosses, but even with weighted branch lines, baits tend to remain near the surface for a period of time. According to Brothers (1995), a frozen bait weighted with about 50 g of lead should sink to three meters depth approximately 30 meters behind a longline vessel setting at eight knots. The efficacy of a combination of weighted branch lines and a line-shooter was estimated to be 97-98% (NMFS, Southwest Fisheries Science Center [SWFSC] Honolulu Laboratory, cited in WPRFMC 2001).

Cost
The cost of a hydraulic line-shooter of the type employed by the Hawaii-based longline fleet and its installation amounts to about $5,700 (Jim Cook, Pacific Ocean Producers, pers. comm.). Weighted branch lines are estimated to be a recurring annual cost of $1,200 per vessel, and annual equipment maintenance is estimated to cost $1,200 per vessel.

2.1.3.4 Tori line

Operational characteristics
Based largely on the precedent set by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR), tori lines (also called streamer lines) have become the most commonly prescribed seabird interaction reduction device in world longline fisheries. A tori line, a type of towed deterrent, is basically a line suspended from a high pole on the stern of the vessel and extending astern to a buoy or float that keeps the line taught. Streamer lines are attached at intervals along the main line and extend down to the water's surface. Other towed deterrents, including such things as inflated trash bags, have been tried by fishermen, but no data are available on their effectiveness. They are not considered further in this EIS.

Tori lines protect baited hooks which are accessible to seabirds at the water's surface, and force birds to forage further behind the fishing vessel, giving the baits a chance to sink. The effectiveness of tori lines is reduced under conditions where the tori line is not over the baits, such as when winds and currents are in very different directions. McNamara et al. (1999) noted that rough weather may substantially decrease the effectiveness of tori lines, and these devices can quickly become entangled with fishing gear if not closely monitored. An entanglement leaves baited hooks accessible to seabirds unless another tori line is immediately deployed. The problem of keeping the bird scaring line clear of fishing gear and positioned over the baited hooks is particularly acute at night because of reduced visibility and during the haul back because of frequent changes in the vessel's direction. The slack put into the main line by a line-shooter increases the risk of it tangling with the tori line under rough or windy conditions. Incorporating break-aways (weak-links) of about 100 to 200 lb tensile strength into the streamer line is highly recommended should the streamer line foul on the groundline. Break-aways at the drag buoy are a minimum precaution. In such situations, the effectiveness of a tori line may be improved by rigging a boom and bridal system that allows the line to be shifted laterally to afford better coverage of the main line.

In addition, McNamara et al. (1999) noted that seabirds themselves occasionally contact branchlines and carry these over the tori line, leading to entanglements. Further, when a longline vessel stops during hauls, the streamers attached to the tori line may cause the tori line to sink, increasing the risk of entanglement with the fishing gear or the vessel's propeller. Entanglement with the fishing gear will usually result in breakage of the line at a planned "weak link," although it's possible to snap the pole. Fishing time is lost while a replacement line is deployed. Entanglement in the propeller may require clearing by a diver who's safety may be compromised by sea conditions, sharks attracted to fresh bait or hooks in the water. The constant attention needed to ensure the proper functioning of the tori line may increase the risk of accidents or injury to fishermen during setting operations.

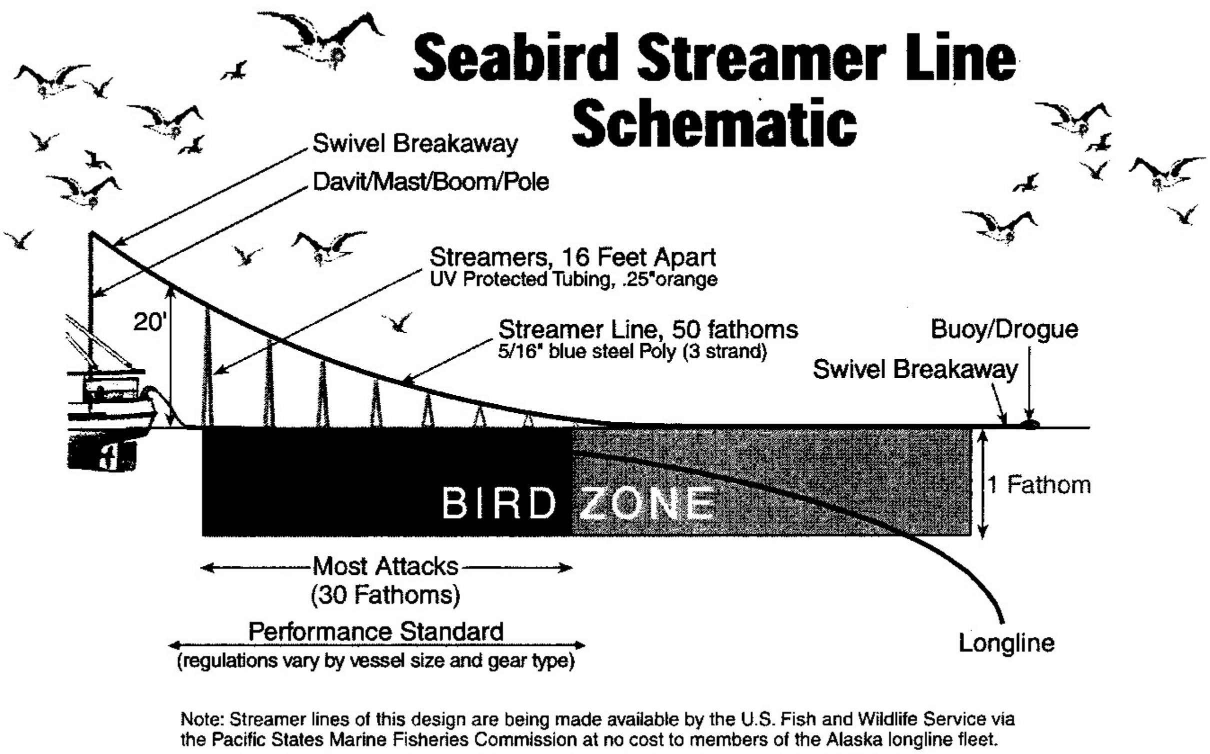
Despite their widespread use, tori line design is not standardized. Boggs (2001) and McNamara et al (1999) both provided specifications for single tori lines that were effective in reducing interactions with seabirds in their studies in Hawaii. Both designs were based on tori lines used aboard pelagic longliners in the southern bluefin tuna fishery (Brothers 1994). In the study conducted by Boggs, a 150 m tori line was composed of a 10 m attachment made of 6 millimeter (mm) yellow twisted polypropylene; a 40 m aerial streamer segment made of the same material with seven forked branch streamers, an 85 m x 3 mm red twisted nylon trailing segment with 8 small streamers on the first 40 m, and a 15 m x 12 mm yellow twisted polypropylene drogue segment. The streamer line was flown from a commercially manufactured fiberglass pole mounted 4 m forward of the stern, extending 10 m above the water and 2 m outboard. The streamer line was about 8 m high at the stern and the ends of the first forked streamer dangled just above the water, 10 m behind the stern, about 5 m directly aft of the bait entry point. It is important to note, however, that Boggs' study was conducted aboard a NOAA research vessel, and thus the mounting of the tori line was higher than would be possible on board a commercial longline vessel.

In McNamara et al.'s (1999) study, the tori line varied from 140 -175 m in length depending on the zone of opportunity established for individual vessels. The line consisted of ¼ inch three strand polypropylene line, and six detachable aerial streamers. The aerial streamers were made of flexible material that moved just above the water's surface. The portion of the tori line that trailed in the water had short (10-25 centimeter [cm]) plastic streamers. The tori line incorporated a 2 inch hollow braid polypropylene drogue section at the terminal end. The tori line was positioned directly above the area where baited hooks were deployed. The height of the attachment point, length of the tori line, and weight of the aerial streamers determined the distance that the aerial streamer portion of the line remained aloft behind the vessel. A tori line of similar length specifications (140 -175m) was also deployed with a buoy at the end of the line, and with 1 m long plastic aerial streamers and 10 inch water streamers.

According to the USFWS BiOp (2004a) tori lines to be used in the Hawaii fishery should comply with the Tori Line Construction Protocols described in Appendix C of *Final Report: Hawaii Longline Seabird Mortality Mitigation Project* prepared by McNamara et al. (1999). The tori line should be positioned directly above the area where the baited hooks are being deployed. This position can be best achieved by securing the tori line to a sturdy fiberglass pole (tori pole) inserted in a swiveling steel base mounted near the stern of the vessel. Prior to deployment of the tori line, fishermen should determine the wind direction relative to the vessel's desired setting course. Immediately after the first radio buoy is released overboard, the tori line should be trailed from behind the vessel. No baited hooks should be set until after the tori line is fully deployed. The tori pole should be positioned so that the aerial portion of the tori line covers the area where baited hooks enter the water while ensuring that the terminal end does not cross the longline or become entangled in suspender floats. Fishermen should throw the baited hooks outside the propeller wash and under the protection of the aerial streamers. The captain and crew should continually monitor the position of the tori line and make adjustments for course changes such that the aerial streamers effectively cover the area that baited hooks enter the water.

Figure 2.1-1 illustrates a typical tori line used in the Alaska demersal longline fishery (Melvin 2000). As noted in the figure, however, rather than prescribe a standard tori line construction for all vessels, establishment of performance standards based on individual vessel configuration and operating characteristics (e.g., setting speed) should be considered in development of specifications for tori lines.

Figure 2.1-1 Schematic of a Tori Line Used in the Alaska Demersal Longline Fishery (Source: Melvin 2000).



Recent experiments and analyses indicate that tori line design should consider the species of birds the line is intended to deter, the sink rate of the baits, and the operating characteristics of the vessel (e.g., stern-setting vs. side-setting, etc.). Rather than precisely specifying the design of the tori line, performance standards should be established for aerial coverage based on the above factors.

Melvin et al. (in press) suggest improvements to the current CCAMLR tori line specifications, including: requiring that the tori line be deployed over the hookline within 100 m of the stern; increasing the height of the tori line attachment point and/or specifying the aerial extent of the tori line; requiring that individual branched streamers extend to the water in the absence of wind and swell and be attached throughout the aerial extent of the tori line; including UV-protected plastic tubing as a permitted streamer line material; relaxing the requirements regarding the number and placement of swivels in favor of a performance standard to prevent twisting and fouling of individual streamers; requiring that tori line attachment points to the vessel and the towed object be deployed to windward of the hookline so that streamers protect the hookline in crosswinds; and recommending that fishers deploy a minimum of two tori lines on a voluntary basis according to performance and material standards, one on either side of the hookline.

It is important that the terminal drogue track straight, even in cross winds and choppy conditions, to keep the line suspended above the baits. Recent experiments by fishermen in Australia found that a standard traffic cone with a square bottom functioned extremely effectively for this purpose (D. Kreutz, pers. comm. to K. Rivera, NMFS).

Compliance
If vessels elect to use this measure, they can be checked at dockside to ensure that appropriate gear is on board. The deployment of a tori line is also highly visible, allowing at-sea monitoring of compliance from an aircraft or cutter. However, as with blue bait and offal discards, monitoring of compliance at-sea is problematic in the absence of on-board observers. Further, compliance monitoring may be problematic even with observers on the vessel. It is not always possible to ensure that the method is being used effectively, resulting in a tori line being deployed, but not over the area of baited hooks. This may result in compliance with the regulations, but negate its effect in avoiding bird capture.

Efficacy
McNamara et al. (1999) and Boggs (2001) evaluated the effectiveness of towed deterrents, including tori lines on Hawaii-based longline vessels and using a research vessel, respectively. The observations conducted by those investigators were on longline gear rigged to fish shallow for swordfish. In the McNamara study, tori lines reduced seabird captures by 79% and towed buoys reduced captures by 88%. In the Boggs study, tori lines reduced contacts with the line by 76%.

Cost
The equipment for a tori line amounts to about $2,000 for the fiberglass pole and $300 for the line and streamers. Installation of a mount and miscellaneous hardware for the tori line is estimated to cost about $1,000. Total costs associated with a single tori line are thus likely to be about $3,300. If this measure were required, prudent operators would likely have a spare pole and tori line available in the event of breakage, and this is assumed in estimating in Chapter 4, costs for alternatives incorporating this measure.

2.1.3.5 Night-setting

Operational characteristics
Setting longlines at night has historically been part of the standard operating procedures for Hawaii-based longline vessels making shallow-sets targeting swordfish. Hooks set at or before dusk, however, are a threat to crepuscular feeders such as albatross. Some operators in the Hawaii-based fleet historically set their hooks according to a lunar calendar and that sometimes resulted in pre-dusk setting. Current regulations require that shallow-sets north of 23°N latitude be started no earlier than one hour after local sunset and completed no later than local sunrise, using only the minimum vessel lights necessary for safety. This measure is predicated on birds' inability to see gear and bait in the dark, so its effectiveness likely is influenced by cloud cover, moon phase, vessel lighting and use of light sticks. Consequently, the observer data (and estimated seabird interactions) for the period 1994-1999 (prior to implementation of the current definition of and requirement for nighttime shallow sets) represents a mixture of pre-dusk and true night-setting. There is a common belief among some fishermen that the hooks deployed

before dark are generally more effective at catching fish than those set after dusk (Brian MacNamara, pers. comm.).

Compliance
Vessels opting to target swordfish in the shallow-set sector of the fishery reauthorized in 2004 will have to declare their intent to make shallow-sets prior to departure. They will be required to carry an observer, who will note the start and finish times of sets as part of their duties, and therefore establish a record of compliance with the requirements for the timing of the start and termination of sets. Should observer coverage be reduced in the future, data collected via the VMS system could be used to verify the start and finish of setting and hauling.

Efficacy
Unlike the other measures considered here, which tend to work similarly on Laysan and black-footed albatross, night-setting is more effective at minimizing interactions with black-footed albatross than with Laysan albatross, which may continue to feed after dark and therefore may dive on baited hooks being deployed after dusk. McNamara et al. (1999) found that black-footed albatross captures were reduced by 95%, but Laysan albatross captures were only reduced by 40%. Boggs (2003) showed that shallow-setting at night reduced overall captures by 98% and contacts by 93%.

Cost
There are no additional financial costs known to be specifically associated with night-setting, however, when fishing at high latitudes in summer, nights are shorter, giving fishermen less time to set gear.

2.1.3.6 Underwater Setting Chute

Operational characteristics
Although underwater setting chutes have been used successfully in other fisheries, two lengths of chutes (9 m and 6.5 m) used by Gilman et al. (2003) in experiments in Hawaii using deep-set gear were found to have design flaws that affected their performance. The 9 m chute fractured and bent on one fishing trip, and even when repaired had a markedly reduced performance operationally and in terms of mitigating seabird interactions. Even the shorter chute, however, requires a lot of deck space to stow when not fishing and in transit to and from fishing grounds, which may be a problem on smaller vessels. During sea trials described by Gilman et al. (2003) crew perceived the underwater setting chute to be unwieldy to deploy and retract. However, a more efficient system to deploy and retract the chute could be designed and installed if a vessel were to install a chute for permanent use. Crew found setting with the chute to be less messy than conventional setting, as bait does not splatter and hit the crew when setting bait through the chute.

Gilman et al. note that there is concern that, even if all the chute's engineering deficiencies were fixed, it may be an insurmountable problem to avoid having gear getting occasionally tangled around the chute for vessels that set their main line slack, such as in the Hawaii longline tuna fleet. In particular, when there is a large swell, use of the chute causes fouled hooks and gear tangles. When tangles cause hooks to come up prong first during hauling a safety hazard is created for crew. The two causes of the increased incidence of gear tangles when using the chute, timing of crew clipping branch lines to the main line and bin tangles, are avoidable, but they may be frequent with new and inattentive crew.

An additional problem noted by Gilman et al. (2003) for deep-setting vessels is that the chutes tested caused delays in setting the branch lines that could reduce the number of hooks deployed per set by 12.5% for the 9m long chute and 28.8% for the 6.5m long chute. The chute would not cause a delay in the conventional hook setting rate for shallow-setting vessels. Shallow-setting vessels set hooks at 12 second intervals compared with the 8 second interval used by deep-setting vessels.

Compliance

The deployment of an underwater setting chute could be monitored from an aircraft or cutter. However, as with several previously described measures, monitoring of compliance at-sea would be problematic in the absence of on-board observers. The presence of a setting chute on-board a vessel at the dock does not insure its use at sea.

Efficacy

Trials with underwater setting chutes on Hawaii-based longline vessels have been conducted by Gilman et al. (2003). Initial trials with a 9m chute in the longline tuna fishery, where the chute deployed baited hooks 5.4m underwater, eliminated bird captures. Efficacy was greatly reduced, however, after the chute failed structurally and repairs were attempted. The efficacy values used later for comparisons of the alternatives assume a fully functional chute. Efficacy of a shorter chute (6.5 m) was found to be 88% (Gilman et al. 2003).

Cost

The acquisition of an underwater setting chute is a major expense, currently estimated to be about $5,000, with additional costs estimated at $1000 for installation of mounts and hardware. Custom fabrication is necessary. Although underwater setting chutes are available for other fisheries, chutes of a configuration suitable for use in the Hawaii longline fishery are not mass produced.

2.1.3.7 Side-setting

Operational characteristics

Side-setting involves deployment of the main longline from the side of the vessel rather than from the stern as has traditionally been done. Some Hawaii-based longline vessels have voluntarily adopted side-setting, but may not have adopted certain enhancements to the technique that maximize its efficacy. Side-setting is defined herein to include the following specifications:

1. Attach 60 g weights within 1 m of the hook on each branchline;
2. Side-set as far forward from the stern as possible;
3. Deploy a bird curtain between the setting position and the stern;
4. Throw baited hooks forward as close to the vessel hull as possible; and
5. Clip deployed branchlines to the mainline the moment that the vessel passes the baited hook to minimize tension in the branch line, which could cause the baited hook to be pulled towards the sea surface.

Side-setting minimizes bait theft and bird capture, thus increasing fishing efficiency by increasing the number of baits at work. It also increases the fishing efficiency in another way. Vessels with the wheel house positioned amidships or aft of the vessel conventionally set their lines from the aft deck, and retrieve the line from the foredeck. All the retrieved gear is then carried manually to the aft deck for baiting and setting. Side-setting eliminates the need to transport the gear aft before each set, reducing the work load for crew.

Gilman et al. (2003) noted that, in comparison to conventional stern-setting, side-setting may improve fishing efficiency by increasing the hook setting rate. Moreover, the increased retention of bait by avoiding bird interactions may increase target fish CPUE. Gilman et al. also identified the following important operational benefits to side-setting, especially for vessels with an aft wheelhouse and main work deck forward of the vessel's wheelhouse:

1) Side-setting allows for better supervision of fishing operations by the vessel captain from his work station on the bridge, providing safety and efficiency advantages;

2) Instead of having two separate work areas as is necessary when line-setting is carried out from the vessel's stern, at the stern for line-setting and at midship for line hauling, side-setting permits a vessel to have a single work area. When side-setting, all of the gear can be stored at a single area, allowing for the area where the gear is stored to be condensed, which could be a important benefit for smaller vessels. Side-setting would provide considerably more deck room on all vessels, even those with a forward wheelhouse;

3) Vessels conventionally setting from the stern would move totes, line buoys, and radio beacons between the mid-ship hauling position and the stern setting position when stern-setting. They also would move large quantities of bait from the forward storage freezer to the stern for line-setting. Some of these vessels have very narrow passageways along the starboard side of the vessel where they have to move the gear back and forth between each set and haul, forcing some vessels to use narrow and small bins. Some vessels have a conveyer belt system down the port side to transport fishing gear from the line haul work area to the aft line-setting work area. Crew would no longer have to move the gear from setting to hauling positions when side-setting, and a considerable amount of valuable deck space would be freed up now that the vessel no longer has to accommodate an aft line-setting position.

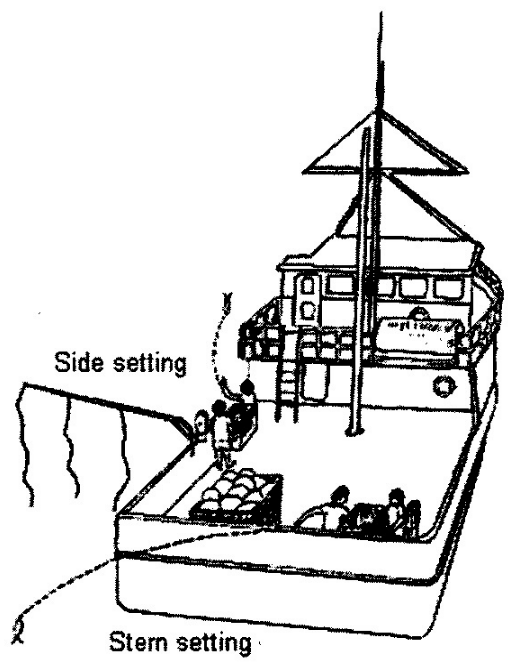
In addition, Gilman et al. state that there may be fewer gear tangles when side-setting compared to conventional stern setting. During sea trials there were no incidences of gear being fouled in the propeller while side-setting from various setting positions. On a few occasions, researchers had the vessel turn hard to starboard and hard to port in an attempt to determine of this would foul the gear during side-setting, and found that it did not. However, Gilman et al. recommend that sea trials be conducted on a variety of vessel lengths and designs to determine if bait loss off hooks and line tangling or cutting such as from contact with propellers are problematic.

Gilman et al. state that a possible negative effect of side-setting on fishing vessel safety is that the crew member clipping branch lines has an increased risk of injury from hooks when there are tote tangles because of the direction branch lines go off of the vessel, as compared to conventional stern setting. Some fishermen have also expressed concern about the 60 g weights recommended for use with side-setting. The requirement to use lead weights on monofilament line always carries with it an element of danger. A lead swivel propelled towards a boat by a snapping nylon leader has sufficient force to cause serious injury, and a 60 g weight would present more of a danger than a 45 g weight.

Gilman et al. indicate that there may be occasional inconvenience and discomfort for crew when side-setting in heavy weather when it cannot be avoided to have the swell come onto the side where setting is occurring. This would be a more noticeable problem on smaller vessels.

Compliance
Side-setting is relatively easy to enforce as the orientation of the gear on deck can be checked through dockside inspection, and vessel operations can be readily observed at sea. It would be possible to reconfigure a vessel from side-setting to stern-setting while at sea but, because of the operational benefits described above, there would seem little motivation to do so. Fifteen vessels (approximately 13% of the fleet) have voluntarily made the conversion to side-setting (Sean Martin, HLA, pers. comm.), presumably due to the operational benefits noted above. A schematic illustration showing a port-side forward side-setting position with a bird curtain and a conventional stern-setting position is shown in Figure 2.1-2.

Figure 2.1-2 Stern-and Side-setting Deck Positions (Source: Gilman et al. 2003).



Efficacy
Side-setting under experimental conditions has been shown to virtually eliminate bird capture (efficacy range 99.6-100%). In deep-set trials conducted by Gilman et al. (2003), side-setting had the lowest mean seabird contact and capture rates of the seabird avoidance treatments tested (two lengths of underwater setting chutes, blue-dyed bait) when used with both Hawaii longline tuna and swordfish gear. More recently, observer data (August 2003 – October 2004) analyzed by Gilman (2004) indicate that vessels employing side-setting did not record a single seabird capture. However, caution must be exercised when looking at observer data, which unlike experimental data, merely record the presence or absence of seabirds and do not normalize the

data for bird abundance. Few data are available for its performance on vessels that have voluntarily adopted it, and those that have adopted it have not necessarily practiced it according to the specifications that would be required. Further, it is uncertain if all vessels in the Hawaii-based fleet could physically convert to side-setting. It is also unknown whether seabirds would become accustomed to the technique, and learn to approach closer to a vessel's hull to take a bait. For these reasons, it appears premature to mandate use of this measure in the fleet.

Cost
Converting to side-setting would generally require some adjustment of the deck design. According to WPRFMC (2004c), a typical vessel in the Hawaii longline fleet would have to spend about $1,500 to alter its deck design for side-setting. Gilman et al. (2003) noted that several aspects of a vessel's layout need to be considered when planning to convert to side-setting, including the feasibility of setting from the port versus starboard side; new position for the line-shooter; and location for buoy, radio beacon, and branch line tote storage. A central principle is that the further forward the setting position is from the vessel stern, the more effective side-setting is at avoiding seabird interactions (also, the further forward the setting position, the easier it is to contend with tote tangles and inadvertently badly thrown baits). According to Gilman et al., a vessel needs a minimum of 0.5 m from the stern corner to allow space to mount a bird curtain aft of the line-shooter. Sea trials described by Gilman et al. demonstrated that it is possible to adjust the gear to side-set from various deck positions without any apparent compromise to the effectiveness of the method at avoiding seabird interactions, indicating that it is most likely a feasible seabird avoidance method on a variety of vessel deck designs.

Gilman et al. (2003) concluded that it is likely that side-setting can be employed on all vessels in the Hawaii-based longline fleet;[16] however, the researchers noted that a small number of vessels in the fleet may have limited options to mount line-shooters for side-setting from a position far forward from the stern. Industry representatives indicated that some boat owners may need to reconfigure the entire deck of their vessels before they could employ side-setting, including moving the mainline spool (pers. comm., Karla Gore, NMFS Pacific Islands Fisheries Regional Office, 4/28/04). Such a reconfiguration could entail substantial expenses for labor and materials as well as lost fishing time. Smaller vessels, in particular, may find it costly to convert to side-setting because of structural limitations (pers. comm., Karla Gore, NMFS Pacific Islands Fisheries Regional Office 4/28/04, WPRFMC 2004c). Because reconfiguring some vessels for side-setting may be expensive, the WPFMC has recommended that NMFS provide low-interest loans or State of Hawaii Fisheries Disaster Relief Program funds to fishermen to reduce these costs (WPFMC, 123rd Meeting, June 21-24, 2004).[17]

Conversion to side-setting means that all operations can be conducted from the foredeck with the elimination of the gear transfer between sets. The initial expense of adjusting the vessel deck

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[16] The statement that there is no boat in the Hawaii-based longline fleet that can not be reconfigured for side-setting has recently been reiterated by an industry representative (pers. comm., Sean Martin, HLA, 11/08/04). This representative also expressed doubt that small vessels would find it more costly to convert to side-setting.

[17] The 2003 Omnibus Appropriations bill appropriated a lump sum of $5 million for economic assistance to Hawaii fisheries affected by federal fishery management regulations.

design ($1,500), fabricating or purchasing a bird curtain ($50), and switching from 45 g to 60 g weighted swivels ($2,500) is estimated to be at least $1,550, depending on the necessity of purchasing heavier swivels. Recurring costs include replacement of the bird scaring curtain. However, costs for every vessel will be different, depending on the specifics of the vessel's design, and costs for some vessels may be considerably higher. The safety concerns associated with the heavier weights could have associated indirect costs in the event of injury.

2.1.3.8 Summary Comparison of Individual Seabird Interaction Avoidance Measures

Table 2.1-1 rates the seabird interaction avoidance measures on the basis of the qualitative criteria described above. Qualitative ratings of the measures were assigned by consensus of a subcommittee of the Fishery Management Action Committee (FMAT) for the seabird action (see Chapter 6 for composition of the FMAT) consisting of representatives of PIRO, the WPFMC and consultants.

Table 2.1-1 Qualitative Appraisals of Seabird Interaction Avoidance Measures (●= good; ●●= better; ●●●=best).

Seabird Interaction Avoidance Measure	Evaluation Criteria	
	Operational Characteristics	Compliance
Thawed, blue-dyed bait (TBDB)	●●	●
Strategic offal discards (SOD)	●◖	●
Line-shooter with weighted branch lines (on tuna vessels)	●●●	●●●
Tori line (TL)	●	●
Night-setting (on swordfish vessels) (NS)	●●	●●
Underwater setting chute (USC)	●	●
Side-setting (with bird curtain and 60 g swivels within 1m of the hook) (SS)	●●◖	●●●

Source: Seabird FMAT subcommittee.

Line-shooters (for deep-setting vessels) and side-setting were rated highest operationally and for compliance. Deep-setting vessels in the Hawaii-based fleet routinely employ line-shooters. In addition to having excellent seabird interaction avoidance characteristics, in initial testing, side-setting was shown to increase fishing efficiency, while being easy to enforce. Night-setting is discounted operationally because it prevents fishermen targeting swordfish from setting lines at or before dusk, or by a lunar calendar, practices which some fishermen believe increase catch rates. Night-setting is required for swordfish longlining. Thawed, blue-dyed bait and strategic offal discard are discounted further because of the disincentives to compliance and difficulty of monitoring compliance. Tori lines and underwater setting chutes were rated lowest due to their operational liabilities and difficulty of monitoring compliance.

As promising as side-setting appears to be, however, there are compelling reasons to maintain an element of flexibility in the methods available to operators in the Hawaii-based longline fishery. First, it has yet to be demonstrated that all vessels in the fleet could cost-effectively make the conversion. Second, experience in the Alaska demersal longline fishery has shown that a stepwise approach may be more prudent than broad implementation of a measure with limited operational history in the fishery (Kim Rivera, NMFS, Northwest Region, personal communication). Although seabird interaction avoidance measures can be shown to be effective under experimental conditions, their performance characteristics must be evaluated under operational conditions during routine fishing operations through the use of on-board observations (Kim Rivera, NMFS, North Pacific Region, personal communication). A complete conversion to side-setting by one or both fishery sectors would effectively remove the “control” portion of the experiment. The information to be gained from a “with and without” comparison would be lost, and further systematic evaluation of this technique would be difficult (Christofer Boggs, PIFSC, personal communication). In addition, should seabirds prove to become habituated to side-setting, its effectiveness would be lost and vessels would have undergone reconfigurations for little purpose.

Table 2.1-2 summarizes from experiments done in the Hawaii-based longline fishery the reduction in seabird capture rates for the seabird interaction avoidance measures described above and included in the alternatives presented later in this chapter. Bolded values are considered the best estimate of a measure’s efficacy and are used in estimating the efficacy of combinations of measures included under each alternative. The efficacy percentages are relative to a “no avoidance measure” baseline, although in the case of deep-setting tuna vessels, the baseline includes use of a line-shooter with weighted branch lines. The experiments from which these efficacy values are taken were conducted using either deep-set tuna gear or shallow-set swordfish gear, but not both. Because we have no better data, in later calculations we apply the same experimental efficacy for a given measure to both sectors of the fishery. Bolded values in parentheses in Table 2.1-1 are the values applied to deep sets from experiments with shallow sets, or vice versa. Most experiments used shallow-set longline gear. It seems likely that application of those efficacy values to deep sets is conservative because baits are expected to sink beyond reach of the albatrosses more rapidly in that style of fishing. The efficacy value for underwater setting chutes came from an experiment using deep-set tuna gear. The nature of an underwater setting chute is such that it discharges the bait at a depth too deep for albatrosses to reach. Thus, regardless of which sector of the fishery employed that measure, the efficacy should be the same. The efficacy value for blue-dyed fish bait also came from an experiment using deep-set tuna gear. A comparable value for swordfish gear is unavailable. All of these data and results of experiments with other interaction avoidance measures are summarized in Gilman et al. (2003).

The results in Table 2.1-2 are from experiments conducted on a NOAA research vessel or on a commercial longline vessel, with detailed information recorded on interactions. In both instances the number of seabirds around the longline vessel was recorded along with the number of attempts and contacts with bait and/or the fishing line, and captures of seabirds. In contrast, observers deployed by NMFS on Hawaii-based longline vessels record seabird abundance within about 150 m of the vessel or around the gear at variable times during a fishing trip. However, most observations of seabird abundance are made by the observers during the haul, which typically occurs during the afternoon and at night in the Hawaii longline tuna fleet. Albatross abundance is generally lower at night than during the day. It is also very difficult to accurately estimate bird abundance around the vessel in the dark (McNamara et al. 1999). As such, observer data collected by NMFS since the inception of seabird interaction avoidance requirements in 2001 cannot be treated in the same way as experimental data when looking at the efficacy of different methods. Gilman (2004) has analyzed observer data where albatrosses were recorded as present, but the number unknown. Gilman showed that stern set longlines with blue-dyed fish bait caught over 75% fewer seabirds than stern set longlines with untreated fish-bait, although the confidence limits overlapped. In another analysis, using a slightly larger data set, Gilman showed that there were no significant differences between blue-dyed fish bait used in combination with 45 g and 60 g weighted branch lines versus untreated fish bait. However, it is important to note the caveats given above about comparing observer and experimental data in the absence of normalization for seabird abundance (i.e., expression of interaction rates as contacts or captures per 1000 hooks per bird).

Gilman et al. (2003) explains that even when normalized for seabird abundance, efficacies can show a high degree of variability from one year to another and one experiment to another. Moreover, the variances about the point estimates are very wide and overlapping in many cases (Christofer Boggs, Pacific Islands Fisheries Science Center, pers. comm.). Gilman et al. cite a difference in control treatment capture rates of over 38 times in experiments by different researchers in different years, and over nine times in experiments by the same researcher in different years. Factors confounding comparisons include weather, season, bird behavior, bird species complex, fishing practices (e.g., time of day when setting, use of deck lighting at night, offal discharge practices, type and condition of bait, amount and location of weights, length of branch lines, size of hooks, crew practices for deploying lines), location of fishing grounds, and consistency in observer's methods. Nevertheless, these are the best estimates we have of absolute efficacies of the measures under consideration, and these values are used later in this chapter to project seabird captures under the various alternatives. Notwithstanding the above, it can be seen that most measures appear to be very effective at reducing capture of seabirds, achieving reductions of 63% or greater, as compared to fishing without any seabird interaction avoidance measures.

It should be noted that for interaction avoidance measures to be optimally effective, their design, construction and use must be adequately defined in the implementing regulations. For example, design standards have not yet been developed for a tori line specifically for use with pelagic longline gear. The relatively low interaction avoidance efficacy seen with tori lines tested for the Hawaii fishery may reflect a less than optimal design for that purpose. Additional research on this measure and indeed most of the measures considered above is still required. Even the apparently excellent characteristics of side-setting were demonstrated in only a limited set of trials.

Any discussion of the efficacy of seabird interaction avoidance measures should also acknowledge the impact of captured bird drop-offs. The absolute number of birds counted as hooked on the set in experimental observations is subject to error from drop-offs or loss by predation of hooked and drowned birds from the longline. However, assuming that bird drop-off and loss is constant, this will not affect the relative comparison between different methods and controls. Estimates of drop-offs and loss in the Hawaii longline fishery have been made by Gilman et al. (2003) which found that 28% fewer birds were hauled aboard than were observed being caught during setting. This is consistent with observations by Brothers (1991) who observed 27% fewer birds on hauls than observed on sets in the Japanese tuna longline fishery in the Southern Ocean. Ward et al. (2004) analyzing observer data from a number of longline fisheries showed that the drop-off and loss of seabirds may be as high as 45% and is related to the length of longline soak time.

Table 2.1-2 Interaction Avoidance Measure Efficacy Values From Experiments Conducted in the Hawaii-based Longline Fishery.

Measure	Tuna (Deep) Set	Reference	Comments	Swordfish (Shallow) Set	Reference	Comments
Thawed, Blue-Dyed Bait (Squid) (TBDS)	Not applicable	---	Squid bait not used for tuna.	95%	McNamara 1999	Squid bait no longer permitted in SF sets.
Thawed, Blue-Dyed Bait (Fish) (TBDF)	**63%**	Gilman et al. 2003		**(63%)**	---	Use tuna efficiency for SF.
Strategic Offal Discharge (SOD)	**(86%)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	**86%**	McNamara 1999	
Night-setting (NS)	Not applicable	---	Night-setting not used for tuna.	73% 98% Mean = **85.5%**	McNamara 1999 Boggs 2003	Mean value of two studies used in calculations.
Night-Setting + Thawed, Blue-Dyed Squid	Not applicable	---	Neither night-setting nor squid bait used for tuna.	100%	Boggs 2003	Squid bait no longer permitted in SF sets.
Underwater Setting Chute (USC)	88% (6.5m) 100% (9m) Mean = **94%**	Gilman et al. 2003	Assumes fully functional chutes.	**(94%)**	---	Assumes chute functionality equal to deep sets.
Single Tori Line (TL)	**(79 %)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	**79%**	McNamara 1999	
Paired Tori Lines	No data	---		No data	---	
Side-setting (SS)	**(99.8%)**	---	Use SF efficiency for tuna. Appears conservative for deep sets.	99.6-100% Mean = **99.8%**	Gilman et al. 2003	

Table 2.1-3 summarizes the estimated initial and recurring costs per vessel for implementation of the seabird interaction avoidance measures. The bases for these costs are given in section 4.8. Given that the typical Hawaii-based longline vessel has annual costs on the order of $450,000, the costs for any one of these measures would represent a small fraction of that. Not included in these costs are those costs potentially associated with permit program administration or enforcement, or indirect costs such as those that might result from injuries caused by the heavier 60 g weights recommended to be used when side-setting.

Table 2.1-3 Summary of Costs per Vessel for Seabird Interaction Avoidance Measures.

Avoidance Measure	Cost per Vessel
Thawed, blue-dyed bait	$1,400 annual
Strategic offal discards	$150 initial
Line-shooter with weighted branch lines (45 g) (on tuna vessels)	already purchased and being used ($5,700 initial + $2,400 annual maintenance and new weights)
Tori line	$1,000 set-up + $2,300 annual per line
Night setting (on swordfish vessels)	$0
Underwater setting chute	$6,000 initial
Side-setting (+ 60 g swivels within 1m of the hook)	$1,500 or more for initial deck work + $50 for bird curtain (annual) + $2,500 for new swivels, if necessary

2.1.4 Combinations of Measures for Reduction of Longline-Seabird Interactions

2.1.4.1 Qualitative Assessments of Combinations of Avoidance Measures

This section qualitatively examines combinations of the available seabird interaction avoidance measures to see if any combinations would be an obvious improvement over single measures. Table 2.1-4 is a matrix for combining individual seabird interaction avoidance measures for evaluation of all possible pairs of measures. Combinations are discussed by number in the paragraphs below as is the issue of whether individual measures would be anticipated to perform independently of each other (and thus tend to have an additive or cumulative effect) or whether they would interact with each other (either positively or negatively). Quantitative estimates of the efficacies of combinations of measures appearing in the alternatives are made in the next section.

Table 2.1-4 Seabird Interaction Avoidance Measure Combination Matrix.

Measure	Thawed, Blue Bait	Strategic Offal Discard	Line-shooter	Tori line	Night-Setting	Setting Chute	Side-setting
Thawed, Blue Bait	Individual measure characteristics	1	2	3	4	5	6
Strategic Offal Discard		Individual measure characteristics	7	8	9	10	11
Line-shooter			Individual measure characteristics	12	13	14	15
Tori line				Individual measure characteristics	16	17	18
Night-Setting					Individual measure characteristics	19	20
Setting Chute						Individual measure characteristics	21
Side-setting							Individual measure characteristics

Combination 1: Thawed, blue-dyed bait with strategic offal discard

These measures are independent of each other, and would tend to be additive in their effects. Both measures have merits, however each has intrinsic limitations in the current fishery, as described above. Blue dye is not as effective for coloring fish (now required for shallow sets) as it is for squid. Tests in New Zealand showed that dye uptake in bait fish was poorest for pilchards, most like mackerel of the baits tested (Greg Lydon, SeaFIC, pers. comm.). Strategic offal discards may condition birds to associate longline vessels with food, thereby attracting more birds to the vessel and increasing the risk of interactions. If this occurs, the measures would tend to counteract each other, and the combined efficacy would not be additive.

Combination 2: Thawed, blue-dyed bait with line-shooter and weighted branchlines (minimum 45 g)

The measures are independent, and would tend to be additive in their effects. However, line-shooters previously have not been required for shallow-setting in the Hawaii longline fishery, and blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait for swordfish.

Combination 3: Thawed, blue-dyed bait with tori line

Since 2000, tori lines have been included in applicable regulations as an optional measure for both deep and shallow-sets. There is anecdotal evidence that some Hawaii-based longline vessels employ tori lines in some circumstances, although this measure may have reduced effectiveness in rough waters. These two measures are independent, and would tend to be additive in their effects, however, blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait; tori lines do not always shield the baits from birds and they present a risk of entanglement with the main line or the propellor.

Combination 4: Thawed, blue-dyed bait with night-setting
The measures are independent of each other, and would tend to be additive in their effects, although blue bait may be unnecessary during darker moon phases or periods of high cloud cover, and blue dye is not as effective with the mackerel-type bait now required for shallow sets as it was with the squid formerly used as bait.

Combination 5: Thawed, blue-dyed bait with setting chute
The measures are independent of each other, and would tend to be additive in their effects. Blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait. The setting chute, as tested in the Hawaii longline fishery to date, has design deficiencies that make it operationally problematic.

Combination 6: Thawed, blue-dyed bait with side-setting
The measures are independent of each other, and would tend to be additive in their effects. Blue dye is not as effective with the mackerel-type bait now required for shallow-sets as it was with the squid formerly used as bait.

Combination 7: Strategic offal discard with line-shooter
The measures are independent of each other, and would tend to be additive in their effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels. If this occurs, the measures would tend to counteract each other, and the combined efficacy would not be additive.

Combination 8: Strategic offal discard with tori line
The measures are independent of each other, and would tend to be additive in their effects. There is anecdotal evidence that some Hawaii-based longline vessels employ tori lines in some circumstances. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels, and tori lines present a risk of entanglement with the main line or the propellor.

Combination 9: Strategic offal discard with night-setting
The measures are independent of each other, and would tend to be additive in their effects. However, to the extent birds discontinue feeding at night, strategic offal discard would presumably be less effective (although albatrosses do have a well developed sense of smell) and, as noted above, may condition birds to approach longline vessels. If this occurs, the measures would tend to counteract each other, and the combined efficacy would not be additive.

Combination 10: Strategic offal discard with setting chute
The measures are independent of each other, and would tend to be additive in their effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels. If this occurs, the measures would tend to counteract each other, and the combined efficacy would not be additive. The setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 11: Strategic offal discard with side-setting
The measures are independent of each other, and would tend to be additive in their effects. Strategic offal discard is effective in luring birds away from the baits, but as noted above, may condition birds to approach longline vessels. If this occurs, the measures would tend to counteract each other, and the combined efficacy would not be additive.

Combination 12: Line-shooter with tori line
The measures are independent of each other, and would tend to be additive in their effects. The slack put into the main line by the line-shooter increases the risk of it tangling with the tori line under rough or windy conditions.

Combination 13: Line-shooter with night-setting
The measures are independent of each other, and would tend to be additive in their effects. Operationally however, line-shooters (when used to sink the bait faster) are used for deep, tuna sets, which are done during daylight hours, and night-setting is done for shallow, swordfish sets. The interaction avoidance value of a line-shooter is in its ability to promote rapid sinking of the baits. When used for shallow sets its effectiveness is negated. These analyses assume the line-shooter is used to rapidly sink the baits in making deep sets. The combination is not a practical one for either sector of the fleet, and does not appear as an option in any of the alternatives.

Combination 14: Line-shooter with setting chute
The measures would not be independent, as the main line would be shot through the chute. Preliminary tests of the setting chute were performed using a line-shooter, but the chute has design deficiencies that make it operationally problematic.

Combination 15: Line-shooter with side-setting
The measures would not be independent, as the line-shooter would deploy line from the side of the vessel. This is how the line-shooter was tested by Gilman, et al. (2003), and it worked very well.

Combination 16: Tori line with night-setting
The measures are independent of each other, and would tend to be additive in their effects. Towing a deterrent at night when visibility is limited, however, would exacerbate the problems associated with keeping it clear of the main line or fouling with the propellor. The incremental improvement in deterrence over night-setting alone is likely to be small.

Combination 17: Tori line with setting chute
The measures are independent of each other, and would tend to be additive in their effects. However, the setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 18: Tori line with side-setting
The measures are independent of each other. For this combination to be effective, however, it is assumed that the tori pole would be mounted so as to deploy the streamer line outboard of the vessel, over the main line.

Combination 19: Night-setting with setting chute
The measures are independent of each other, and would tend to be additive in their effects. The setting chute, as tested to date, has design deficiencies that make it operationally problematic.

Combination 20: Night setting with side-setting
The measures are independent of each other, and would tend to be additive in their effects.

Combination 21: Setting chute with side-setting
In combination, these measures would not be independent, and this is an unlikely combination operationally. The chute would have to be exceptionally strong and well braced to withstand the lateral forces as it moves sideways through the water. Limited testing of chutes in the Hawaii fishery have resulted in structural failures when deployed off the stern, where lateral forces are lower. It is unknown how the chute would function if aligned at a right angle to the deployed main line. There could be a tendency to rip the bait from the hooks.

Summary of Qualitative Assessments of Combinations of Measures
In general, combinations involving side-setting appear to give the greatest interaction avoidance potential, but every combination has drawbacks of one sort or another. While side-setting appears to be a very promising method, it appears premature to mandate its use because: 1) it may not be possible for all vessels to cost-effective make the conversion to side-setting, 2) only limited experimentation has been done, and few data are available for its performance on vessels that have voluntarily adopted the method, and 3) it is not known if seabirds will habituate to side-setting.

Combinations employing thawed, blue-dyed bait suffer from the decreased performance of the dye on fish (mackerel-type fish bait is now required to be used in the shallow-set sector of the fishery to minimize sea turtle interactions) as compared with squid, which was formerly used as bait in the shallow-set sector of the fishery. Strategic offal discards may ultimately serve to attract more birds to the vicinity of the longline vessels. Line-shooters can deploy the weighted branch lines at a speed exceeding that of the vessel, creating slack in the line and sinking the baited hooks relatively quickly. They are routinely used in this manner by vessels targeting bigeye tuna in deep sets, and are considered part of the baseline for deep-setting tuna vessels. However, if used by shallow-setting vessels, line-shooters can be adjusted to deploy the longline without slack at the vessel's speed, thus holding the line relatively near the surface. Tori lines may work well when positioned over the baits, but can blow away from the longline or tangle with it. Night-setting is effective and is typically used when shallow-setting for swordfish. It is not used when deep setting, however. Initial tests have shown the setting chute to be unreliable and inconvenient. Additional design development is required to resolve the difficulties encountered in testing of the prototypes.

In consideration of the above, several combinations were not carried forward into alternatives. Combination 13, line-shooter (with line paid out faster than the vessel's speed) with night setting was not practical for either sector of the fleet. Combination 18 (tori line with side-setting) was discarded as not providing added deterrence over side-setting alone. Combination 21 (setting chute with side-setting) was discarded as mechanically unworkable. The most promising combination appears to be side-setting at night, followed respectively by side-setting with a line-shooter, side-setting with blue bait and side-setting with strategic offal discard.

In consideration of the above, a wide variety of alternatives are presented below. These alternatives are generally of the form where vessels may use the suite of measures required by current regulations or one of the individual measures above, but alternatives also are offered which consider requiring side-setting and eliminating thawed, blue-dyed bait and strategic offal discard from the default suite of measures.

2.1.4.2 Quantitative Efficacies for Combinations of Avoidance Measures

In the alternatives described below, some measures are combined. We do not have experimental data for all combinations of measures, therefore several methodologies were considered for calculating the theoretical efficacies for combinations of measures or for a subset of currently required measures. The first approach considered simply used the efficacy value of the measure with the highest efficacy rate. This was rejected as it would result in no added effectiveness when combining clearly independent measures such as thawed, blue dyed bait and weighted branch lines, which would appear to have obvious additive effects. The second approach considered was recommended by the Council's Scientific and Statistical Committee and would multiply the efficacy values of independent measures to arrive at a combined efficacy value. This was rejected as it resulted in most combinations having a combined efficacy value of close to 100%. Given available experimental information, these did not appear to be realistic values. Further, they do not allow for meaningful comparisons to be made between alternatives. The third approach, which was used here, was to first allow one measure to operate at full efficacy (using the efficacy values in Table 2.1-2), then allow the second measure to operate at full efficacy on the remaining undeterred portion of the seabirds present. This analysis can be extended to any number of independent measures and provides a systematic approach to comparing combinations of measures that supports a logical middle ground between the first two approaches. However, it should be kept in mind that these are theoretical calculations based upon experimental data and the results are not likely to accurately portray the efficacy of a combination of measures in an operating fishery. The value of these calculations is that they present a measure of the relative effectiveness of a range of combinations of interaction avoidance measures.

An example of how the technique was applied is as follows. For currently required tuna measures (tuna CM), we calculate the theoretical efficacy as follows: 63% (thawed, blue dyed fish bait (TBDF) efficacy from Table 2.1-2) + (86% [strategic offal discard (SOD) efficacy] x 37% [the undeterred remainder after application of the TBDF measure]) = 94.82%.

The efficacies of the remaining combinations of measures used in the alternatives are as follows.

<u>Swordfish Current Measures (SF CM)</u>
63% [TBDF] + (86% [SOD] of 37% [remainder after TBDB applied]) = 94.82%
94.82% + (85.5% [night-setting (NS)] of 5.18% [remainder after TBDF and SOD applied]) = 99.25%

<u>Tuna CM minus TBDF</u>
Tuna CM is composed of TBDF and SOD. Removing TBDF leaves SOD. The experimental efficacy of SOD is 86%.

<u>SF CM minus TBDF</u>
SF CM is composed of TBDF, SOD and NS. Removing TBDF leaves SOD plus NS. The theoretical efficacy of those two measures is 86% [SOD] + (85.5% [NS] of 14% [remainder after application of SOD]) = 97.97%.

<u>Tuna CM minus TBDB and SOD</u>
This removes all interaction avoidance measures from tuna sets and efficacy goes to 0%.

<u>SF CM minus TBDF and SOD</u>
Removing these two measures leaves night-setting which has an efficacy of 85.5%.

<u>Tuna CM plus Tori Line (TL)</u>
Tuna CM = 94.82% efficacy. To add TL: 94.82% + (79% [TL] of 5.18% [remainder after application of tuna CM]) = 98.91%

<u>SF CM plus TL</u>
SF CM = 99.25% efficacy. To add TL: 99.25% + (79% [TL] of 0.75% [remainder after application of SF CM]) = 99.84%

<u>Tuna CM plus Side-setting (SS)</u>
Tuna CM = 94.82% efficacy. To add SS: 94.82% + (99.8% [SS] of 5.18% [remainder after application of tuna CM]) = 99.99%

<u>SF CM + SS</u>
SF CM = 99.25% efficacy. To add SS: 99.25% + (99.8% [SS] of 0.75% [remainder after application of SF CM]) = 100.00%

<u>Voluntary NS in the South</u>
The experimental efficacy of NS is 85.5%.

<u>SF CM plus TL minus TBDB and SOD</u>
This reduces to NS +TL, or, 85.5% [NS] + (79% [TL] of 14.5% [remainder after application of NS]) = 96.96%.

2.1.5 Alternatives Considered to Meet the Objective of the Seabird Action

2.1.5.1 Descriptions of the Alternatives

In this section a range of alternatives for mitigating the harmful effects of seabird interactions in the Hawaii longline fishery are presented. The "no action" alternative means maintaining the suite of measures implemented by current regulations.

At its 124th meeting (October 12-15, 2004) the Council discarded the preliminary Preferred Alternative (SB7C) of the DEIS, one option of which would delete the requirement for thawed, blue-dyed bait from current measures, in favor of a new Preferred Alternative (SB7D), one option of which added a requirement for tori lines to current measures. This had the effect of eliminating the possibility that some vessels would be permitted to decrease their use of seabird interaction avoidance measures. The Council took under advisement the possibility of deleting thawed, blue-dyed bait and strategic offal discard from the current measures option of the new Preferred Alternative, effectively creating yet another alternative (SB7E). A letter received by the Council from the U.S. Department of the Interior (dated October 15, 2004, but delivered after the 124th Council meeting), stated that thawed, blue-dyed bait and strategic offal discards should be retained as interaction avoidance measures. However, the letter further suggested that strategic offal discards should be used by longline vessels only when seabirds were present. The Preferred Alternative (Alternative SB7D) was modified between preparation of the DEIS and FEIS to reflect that position.

Alternative SB1 No Action: Use current mitigation measures when fishing north of 23°N.

The current measures are as follows[18]:

(a) *Seabird mitigation techniques.* Owners and operators of vessels registered for use under a Hawaii longline limited entry permit must ensure that the following actions are taken when fishing north of 23°N latitude:

> (1) Employ a line-setting machine or line-shooter to set the main longline when making deep sets using monofilament main longlines;
> (2) Attach a weight of at least 45 g to each branch line within 1 m of the hook when making deep sets using monofilament main longlines;
> (3) When using basket-style longline gear, ensure that the main longline is deployed slack to maximize its sink rate;
> (4) Use completely thawed bait that has been dyed blue to an intensity level specified by a color quality control card issued by NMFS;
> (5) Maintain a minimum of two cans (each sold as 0.45 kg or 1 lb size) containing blue dye on board the vessel;
> (6) Discharge fish, fish parts (offal), or spent bait while setting or hauling longline gear, on the opposite side of the vessel from where the longline gear is being set or hauled;

[18] 67 FR 34412, May 14, 2002, as amended by 69 FR 17354, Apr. 2, 2004

(7) Retain sufficient quantities of fish, fish parts, or spent bait, between the setting of longline gear for the purpose of strategically discharging it in accordance with paragraph (a)(6) of this section;

(8) Remove all hooks from fish, fish parts, or spent bait prior to its discharge in accordance with paragraph (a)(6) of this section; and

(9) Remove the bill and liver of any swordfish that is caught, sever its head from the trunk and cut it in half vertically, and periodically discharge the butchered heads and livers in accordance with paragraph (a)(6) of this section.

(10) When shallow-setting north of 23°N latitude, begin the deployment of longline gear at least one hour after local sunset and complete the deployment no later than local sunrise, using only the minimum vessel lights necessary for safety.

(b) *Short-tailed albatross handling techniques.* If a short-tailed albatross is hooked or entangled by a vessel registered for use under a Hawaii longline limited entry permit, owners and operators must ensure that the following actions are taken:

(1) Stop the vessel to reduce the tension on the line and bring the bird on board the vessel using a dip net.

(2) Cover the bird with a towel to protect its feathers from oils or damage while being handled.

(3) Remove any entangled lines from the bird.

(4) Determine if the bird is alive or dead.

(i) If dead, freeze the bird immediately with an identification tag attached directly to the specimen listing the species, location and date of mortality, and band number if the bird has a leg band. Attach a duplicate identification tag to the bag or container holding the bird. Any leg bands present must remain on the bird. Contact NMFS, the Coast Guard, or the U.S. Fish and Wildlife Service at the numbers listed on the Short-tailed Albatross Handling Placard distributed at the NMFS protected species workshop, inform them that you have a dead short-tailed albatross on board, and submit the bird to NMFS within 72 hours following completion of the fishing trip.

(ii) If alive, handle the bird in accordance with paragraphs (b)(5) through (b)(10) of this section.

(5) Place the bird in a safe enclosed place.

(6) Immediately contact NMFS, the Coast Guard, or the U.S. Fish and Wildlife Service at the numbers listed on the Short-tailed Albatross Handling Placard distributed at the NMFS protected species workshop and request veterinary guidance.

(7) Follow the veterinary guidance regarding the handling and release of the bird.

(8) Complete the short-tailed albatross recovery data form issued by NMFS.

(9) If the bird is externally hooked and no veterinary guidance is received within 24–48 hours, handle the bird in accordance with paragraphs (c)(4) and (c)(5) of this section, and release the bird only if it meets the following criteria:

(i) Able to hold its head erect and respond to noise and motion stimuli;

(ii) Able to breathe without noise;

(iii) Capable of flapping and retracting both wings to normal folded position on its back;

(iv) Able to stand on both feet with toes pointed forward; and

(v) Feathers are dry.

(10) If released under paragraph (a)(8) of this section or under the guidance of a veterinarian, all released birds must be placed on the sea surface.

(11) If the hook has been ingested or is inaccessible, keep the bird in a safe, enclosed place and submit it to NMFS immediately upon the vessel's return to port. Do not give the bird food or water.

(12) Complete the short-tailed albatross recovery data form issued by NMFS.

(c) *Non-short-tailed albatross seabird handling techniques.* If a seabird other than a short-tailed albatross is hooked or entangled by a vessel registered for use under a Hawaii longline limited entry permit, owners and operators must ensure that the following actions are taken:

(1) Stop the vessel to reduce the tension on the line and bring the seabird on board the vessel using a dip net;

(2) Cover the seabird with a towel to protect its feathers from oils or damage while being handled;

(3) Remove any entangled lines from the seabird;

(4) Remove any external hooks by cutting the line as close as possible to the hook, pushing the hook barb out point first, cutting off the hook barb using bolt cutters, and then removing the hook shank;

(5) Cut the fishing line as close as possible to ingested or inaccessible hooks;

(6) Leave the bird in a safe enclosed space to recover until its feathers are dry; and

(7) After recovered, release seabirds by placing them on the sea surface.

<u>Alternative SB2A</u>: *Use current mitigation measures <u>or</u> use side-setting, when fishing north of 23°N.*

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, when fishing north of 23°N latitude. Allowing vessel operators to choose between the current measures or side-setting would increase flexibility and address safety concerns by offering the choice of current measures for those vessel operators unwilling to switch to 60 g weights. It also allows for the possibility that not all vessels can be configured for side-setting.

<u>Alternative SB2B</u>: *Use current mitigation measures <u>or</u> use side-setting, in all areas.*

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, in all areas.

<u>*Alternative SB3A:*</u> *Use current mitigation measures <u>or</u> use an underwater setting chute, when fishing north of 23°N.*

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, when fishing north of 23°N latitude.

<u>Alternative SB3B:</u> Use current mitigation measures <u>or</u> use an underwater setting chute, in all areas.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, in all areas.

<u>Alternative SB4A:</u> Use current mitigation measures <u>or</u> use a tori line, when fishing north of 23°N.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ one or more tori lines, when fishing north of 23°N latitude.

<u>Alternative SB4B:</u> Use current mitigation measures <u>or</u> use a tori line, in all areas.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ one or more tori lines, in all areas.

<u>Alternative SB5A:</u> Use current mitigation measures <u>or</u> use side-setting <u>or</u> use an underwater setting chute, when fishing north of 23°N.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, when fishing north of 23°N latitude.

<u>Alternative SB5B:</u> Use current mitigation measures <u>or</u> use side-setting <u>or</u> use an underwater setting chute, in all areas.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, in all areas.

<u>Alternative SB6A:</u> Use current mitigation measures <u>or</u> use side-setting <u>or</u> use an underwater setting chute <u>or</u> use a tori line, when fishing north of 23°N.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (d) employ one or more tori lines, when fishing north of 23°N latitude.

Alternative SB6B: Use current mitigation measures or use side-setting or use an underwater setting chute or use a tori line, in all areas.

Under this alternative, operators of Hawaii longline vessels could elect to either (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (d) employ one or more tori lines, in all areas.

Alternative SB7A: Use current measures or use side-setting or use a tori line, when fishing north of 23°N.

Under this alternative, operators of Hawaii longline vessels could elect to (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ one or more tori lines, when fishing north of 23°N latitude.

Alternative SB7B: Use current measures or use side-setting or use a tori line, in all areas.

Under this alternative, operators of Hawaii longline vessels could elect to (a) continue to use the current measures of Alternative SB1 (No Action), or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) employ one or more tori lines, in all areas.

Alternative SB7C: Swordfish (shallow-setting) vessels use "current" mitigation measures except thawed, blue-dyed bait, or use side-setting, or use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or use a tori line, in all areas. Tuna (deep-setting) vessels use "current" mitigation measures except thawed, blue-dyed bait, or use side-setting in conjunction with a line-shooter and weighted branch lines, or use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or use a tori line in conjunction with a line-shooter and weighted branch lines, when fishing north of 23°N.

Under this alternative operators of Hawaii longline vessels targeting swordfish (shallow-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above except the requirement to use thawed, blue-dyed bait, or (b) employ side-setting according to the specifications given in Section 2.1.3.7, or (c) use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (d) employ one or more tori lines, in all areas.

Operators of Hawaii longline vessels targeting tuna (deep-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above except the requirement to use thawed, blue-dyed bait, or (b) employ side-setting according to the specifications given in Section 2.1.3.7 in conjunction with a line-shooter, or (c) use an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (d) employ one or more tori lines, when fishing north of 23°N latitude.

Alternative SB7D: Swordfish (shallow-setting) vessels use "current" mitigation measures plus a tori line or use side-setting, in all areas. Use strategic offal discard only when birds are present.

Tuna (deep-setting) vessels use "current" mitigation measures plus a tori line <u>or</u> use side-setting in conjunction with a line-shooter and weighted branch lines when fishing north of 23°N. Use strategic offal discard only when birds are present.

This is the Preferred Alternative. Under this alternative operators of Hawaii longline vessels targeting swordfish (shallow-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above with the addition of one or more tori bird-scaring lines, or (b) employ side-setting according to the specifications given in Section 2.1.3.7, in all areas.

Operators of Hawaii longline vessels targeting tuna (deep-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above with the addition of one or more tori bird-scaring lines, or (b) employ side-setting according to the specifications given in Section 2.1.3.7, when fishing north of 23°N latitude.

The Council, at its 124th meeting, identified two versions of its Preferred Alternative, one maintaining current measures as presently required as an option and one deleting thawed, blue-dyed bait and strategic offal discard, (the latter became Alternative SB7E) and sought the input of the USFWS on the appropriateness of those potential modifications to currently required measures. A letter received by the Council from the USFWS dated October 15, 2004, but delivered after the 124th Council meeting, stated that thawed, blue dyed bait and strategic offal discards should be retained as mitigation measures, but that strategic offal discard be used only when seabirds were present. Therefore, this modification has been made part of the Preferred Alternative. Alternative SB7E is no longer a provisionally Preferred Alternative, but is carried forward in the analyses.

<u>Alternative SB7E:</u> Swordfish (shallow-setting) vessels use "current" mitigation measures <u>without</u> blue-dyed bait or strategic offal discards but <u>with</u> a tori line <u>or</u> use side-setting, in all areas. Tuna (deep-setting) vessels use "current" mitigation measures <u>without</u> blue-dyed bait or strategic offal discards but <u>with</u> a tori line <u>or</u> use side-setting in conjunction with a line-shooter and weighted branch lines when fishing north of 23°N.

Under this alternative operators of Hawaii longline vessels targeting swordfish (shallow-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above with the addition of one or more tori lines, but without blue-dyed bait or strategic offal discard, or (b) employ side-setting according to the specifications given in Section 2.1.3.7, in all areas.

Operators of Hawaii longline vessels targeting tuna (deep-setting) could elect to (a) use the measures currently required for vessels fishing north of 23°N latitude as described above with the addition of one or more tori lines, but without blue-dyed bait or strategic offal discard, or (b) employ side-setting according to the specifications given in Section 2.1.3.7, when fishing north of 23°N latitude.

Alternative SB8A: *Use current mitigation measures plus side-setting, when fishing north of 23°N.*

Under this alternative, operators of Hawaii longline vessels would be required to continue to use the current measures of Alternative SB1 (No Action), as well as to employ side-setting according to the specifications given in Section 2.1.3.7, when fishing north of 23°N latitude.

Alternative SB8B: Use current mitigation measures plus side-setting, in all areas.

Under this alternative, operators of Hawaii longline vessels would be required to continue to use the current measures of Alternative SB1 (No Action), as well as to employ side-setting according to the specifications given in Section 2.1.3.7, in all areas.

Alternative SB9A: Use side-setting when fishing north of 23°N.

Under this alternative, operators of Hawaii longline vessels would be required to employ side-setting according to the specifications given in Section 2.1.3.7, when fishing north of 23°N latitude.

Alternative SB9B: Use side-setting in all areas.

Under this alternative, operators of Hawaii longline vessels would be required to employ side-setting according to the specifications given in Section 2.1.3.7, in all areas.

Alternative SB10A: Use side-setting unless technically infeasible[19]*, in which case use current mitigation measures, when fishing north of 23°N.*

Under this alternative, operators of Hawaii longline vessels would be required to employ side-setting according to the specifications given in Section 2.1.3.7 unless technically infeasible, in which case they would be required to use the current measures of Alternative SB1 (No Action), when fishing north of 23°N latitude. Note that the Council, in formulating alternatives, did not define criteria for infeasibility. Presumably any vessel could be reconfigured, cost notwithstanding.

Alternative SB10B: Use side-setting unless technically infeasible, in which case use current mitigation measures, in all areas.

Under this alternative, operators of Hawaii longline vessels would be required to employ side-setting according to the specifications given in Section 2.1.3.7 unless technically infeasible, in which case they would be required to use the current measures of Alternative SB1 (No Action), in all areas.

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[19] The criteria for side-setting infeasibility would be formulated by NMFS, in consultation with the Council and fishing industry, during the rulemaking process.

Alternative SB11A: Use side-setting unless technically infeasible, in which case either use current mitigation measures without blue bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line-shooters with weighted branch lines), or an underwater setting chute or a tori line, when fishing north of 23°N.

Under this alternative operators of Hawaii-based longline vessels would be required to use side-setting according to the specifications given in Section 2.1.3.7 unless technically infeasible, in which case shallow-setting vessels would be required to either (a) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (b) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (c) employ one or more tori lines, when fishing north of 23°N latitude. Deep-setting vessels unable to side-set would be required to either (a) use the measures currently required for vessels fishing north of 23°N latitude, as described above, or (b) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (c) employ one or more tori lines, when setting north of 23°N latitude.

Alternative SB11B: Use side-setting unless technically infeasible, in which case: swordfish (shallow-setting) vessels set at night, or use an underwater setting chute, or use a tori line, and tuna (deep-setting) vessels use current measures, or use an underwater setting chute, or use a tori line, when fishing north of 23°N.

Under this alternative operators of Hawaii-based longline vessels would be required to use side-setting according to the specifications given in Section 2.1.3.7 unless technically infeasible, in which case shallow-setting vessels would be required to either (a) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (b) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (c) employ one or more tori lines, in all areas. Deep-setting vessels unable to side-set would be required to either (a) use the measures currently required for vessels fishing north of 23°N latitude, as described above, or (b) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (c) employ one or more tori lines, in all areas.

Alternative SB12: Voluntarily use side-setting, an underwater setting chute, a tori line, night-setting, or a line-shooter with weighted branch lines, when fishing south of 23°N.

Under this alternative, operators of Hawaii longline vessels would be asked to voluntarily either (a) use side-setting according to the specifications given in Section 2.1.3.7, or (b) employ an underwater setting chute that has a minimum of 2.9 m of its shaft underwater, or (c) employ one or more tori lines, or (d) begin the setting process at least one hour after local sunset and complete the setting process by local sunrise, or (e) use a line-shooter with weights of at least 45 g placed within one meter of each hook, when fishing south of 23°N latitude.

The compositions of the alternatives are summarized in Table 2.1-5.

Table 2.1-5 Seabird Mitigation Measures Included in Each Alternative (Current requirements for annual protected species workshop attendance and seabird handling protocols would be unaffected by any of the alternatives.).

Alt.	Description
SB1 (No Action)	**CURRENT MEASURES** **All Hawaii-based longline vessels** fishing north of 23°N latitude must: Discharge offal and spent bait on the opposite side of the vessel from setting or hauling. Use blue-dyed, thawed bait, and have a minimum of two cans of dye onboard. **Vessels deep-setting** north of 23°N latitude must use a line-setting machine (line-shooter) and use minimum 45 g weights within 1m of each hook, if using a monofilament main line.[1] **Vessels shallow-setting** north of 23°N latitude must begin setting at least 1 hour after local sunset and complete the setting process by local sunrise, using the minimum vessel lights necessary.
SB2A	Use current mitigation measures **OR** use side-setting, when fishing north of 23°N.
SB2B	Use current mitigation measures **OR** use side-setting, in all areas.
SB3A	Use current mitigation measures **OR** use an underwater setting chute, when fishing north of 23°N.
SB3B	Use current mitigation measures **OR** use an underwater setting chute, in all areas.
SB4A	Use current mitigation measures **OR** use a tori line, when fishing north of 23°N.
SB4B	Use current mitigation measures **OR** use a tori line, in all areas.
SB5A	Use current mitigation measures **OR** use side-setting **OR** use an underwater setting chute, when fishing north of 23°N.
SB5B	Use current mitigation measures **OR** use side-setting **OR** use an underwater setting chute, in all areas.
SB6A	Use current mitigation measures **OR** use side-setting **OR** use an underwater setting chute **OR** use a tori line, when fishing north of 23°N.
SB6B	Use current mitigation measures **OR** use side-setting **OR** use an underwater setting chute **OR** use a tori line, in all areas.
SB7A	Use current mitigation measures **OR** use side-setting **OR** use a tori line, when fishing north of 23°N.
SB7B	Use current mitigation measures **OR** use side-setting **OR** use a tori line, in all areas.
SB7C	Swordfish (shallow-setting) vessels use current mitigation measures except thawed, blue-dyed bait, **OR** use side-setting, **OR** use an underwater setting chute, **OR** use a tori line, in all areas. Tuna (deep-setting) vessels use "current" mitigation measures except thawed, blue-dyed bait, **OR** use side-setting in conjunction with a line-shooter and weighted branch lines, **OR** use an underwater setting chute, **OR** use a tori line in conjunction with a line-shooter and weighted branch lines, when fishing north of 23°N.
SB7D (Preferred Alternative)	Swordfish (shallow-setting) vessels use current mitigation measures **PLUS** a tori line **OR** use side-setting, in all areas. Use strategic offal discard only when birds are present. Tuna (deep-setting) vessels use current mitigation measures **PLUS** a tori line **OR** use side-setting in conjunction with a line-shooter and weighted branch lines when fishing north of 23°N. Use strategic offal discard only when birds are present.

Alt.	Description
SB7E	Swordfish (shallow-setting) vessels use current mitigation measures **MINUS** blue-dyed bait and strategic offal discard **PLUS** a tori line, **OR** use side-setting, in all areas. Tuna (deep-setting) vessels use current mitigation measures **MINUS** blue-dyed bait and strategic offal discard **PLUS** a tori line, **OR** use side-setting in conjunction with a line-shooter and weighted branch lines when fishing north of 23°N.
SB8A	Use current mitigation measures **PLUS** side-setting, when fishing north of 23°N.
SB8B	Use current mitigation measures **PLUS** side-setting, in all areas.
SB9A	Use side-setting when fishing north of 23°N.
SB9B	Use side-setting in all areas.
SB10A	Use side-setting **UNLESS** technically infeasible, in which case use current measures, when fishing north of 23°N.
SB10B	Use side-setting **UNLESS** technically infeasible, in which case use current measures, in all areas.
SB11A	Use side-setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** current measures without thawed, blue-dyed bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line-shooters with weighted branch lines), when fishing north of 23°N.
SB11B	Use side-setting **UNLESS** technically infeasible, in which case use an underwater setting chute **OR** a tori line **OR** current measures without thawed, blue-dyed bait or strategic offal discards (shallow-setting vessels set at night, deep-setting vessels use line-shooters with weighted branch lines), in all areas.
SB12	Voluntarily use side-setting, **OR** an underwater setting chute, **OR** a tori line, **OR** a line-shooter with weighted branch lines, **OR** night-setting south of 23°N.

[1]Basket gear may also be used if deep-set longline fishing above 23°N, with a requirement that the mainline be set slack to maximize the sinking of baited hooks.

2.1.5.2 Qualitative and Quantitative Comparisons of the Seabird Action Alternatives

Table 2.1-6 combines summaries of the qualitative criteria and efficacy values for the individual measures included in each alternative. The alternatives consider separately the tuna and swordfish sectors of the fishery, most offer choices of avoidance measures to implement, and many do not apply measures south of 23°N latitude. Consequently, each alternative has several possible combinations of ratings. (No assessment is shown in Table 2.1-6 where no measure is required.) For tuna (deep set) and swordfish (shallow set) current measures, which each consist of a combination of measures, the qualitative ratings shown below represent an average of those of the component measures. Similarly, where a combination of measures is specified as an option in an alternative, the qualitative ratings given represent an average of those of the component measures. All alternatives except SB7 and SB12 have two versions, A and B. These versions differ in where the avoidance measures apply, but the choices of measures are the same. Therefore, in the table below, only one version of each alternative is shown, except for Alternative SB7, where the versions differ substantially. In Chapter 4, the overall efficacies of the alternatives are projected based on assumptions about the proportions of the fleet that would make each of the various choices.

Table 2.1-6 Qualitative and Quantitative Assessments for the Seabird Action Alternatives (●= good; ●●= better; ●●●=best).

Alternative	Sector	Measure	Efficacy (%)	Operational Characteristics	Compliance
SB1 (No Action)	Tuna	CM	94.82	●●	●●
	SF	CM	99.25	●●	●
SB2	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
SB3	Tuna	CM	94.82	●●	●●
		USC	94	●	●
	SF	CM	99.25	●●	●
		USC	94	●	●
SB4	Tuna	CM	94.82	●●	●●
		TL	79	●	●
	SF	CM	99.25	●●	●
		TL	79	●	●
SB5	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●

Alternative	Sector	Measure	Efficacy (%)	Operational Characteristics	Compliance
		USC	94	●	●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
		USC	94	●	●
SB6	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●
		USC	94	●	●
		TL	79	●	●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
		USC	94	●	●
		TL	79	●	●
SB7A	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●
		TL	79	●	●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
		TL	79	●	●
SB7B	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●
		TL	79	●	●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
		TL	79	●	●
SB7C	Tuna	CM-TBDB	86	●●	●●
		SS	99.8	●●◖	●●●
		USC	94	●	●
		TL	79	●	●
	SF	CM-TBDB	97.97	●●	●
		SS	99.8	●●◖	●●●
		USC	94	●	●

Alternative	Sector	Measure	Efficacy (%)	Operational Characteristics	Compliance
		TL	79	●	●
SB7D	Tuna	CM+TL	98.91	●●	●◖
(Preferred		SS	99.8	●●◖	●●●
Alternative)	SF	CM+TL	99.84	●◖	●
		SS	99.8	●●◖	●●●
SB7E	Tuna	CM+TL-(TBDB&SOD)	79	●●	●●
		SS	99.8	●●◖	●●●
	SF	CM+TL-(TBDB&SOD)	96.96	●◖	●◖
		SS	99.8	●●◖	●●●
SB8	Tuna	CM+SS	99.99	●●	●●
	SF	CM+SS	100	●●	●●
SB9	Tuna	SS	99.8	●●◖	●●●
	SF	SS	99.8	●●◖	●●●
SB10	Tuna	CM	94.82	●●	●●
		SS	99.8	●●◖	●●●
	SF	CM	99.25	●●	●
		SS	99.8	●●◖	●●●
SB11	Tuna	SS	99.8	●●◖	●●●
		CM-(TBDB&SOD)	0	●●●	●●●
		USC	94	●	●
		TL	79	●	●
	SF	SS	99.8	●●◖	●●●
		CM-(TBDB&SOD)	85.5	●●	●●
		USC	94	●	●
		TL	79	●	●
SB12	Tuna	SS	99.8	●●◖	●●●
		USC	94	●	●
		TL	79	●	●
		CM	94.82	●●	●●

Alternative	Sector	Measure	Efficacy (%)	Operational Characteristics	Compliance
	SF	SS	99.8	●●◖	●●●
		USC	94	●	●
		TL	79	●	●
		CM	99.25	●●	●

2.1.6 Seabird Action Alternatives Considered but Eliminated from Detailed Study

The strategy adopted to meet the seabird action's objective is to reduce the rate of longline-seabird interactions. The alternative strategy, to reduce the consequences of interactions, is represented in current regulations by two measures, mandatory seabird handling techniques and annual attendance at a NMFS protected species workshop (see Section 2.1.1.2). It is expected that these measures will remain in effect regardless of other changes in the management regime for the Hawaii-based longline fishery. They are not a part of the current action and will not be affected by it. No alternatives to eliminate or modify these measures were evaluated.

Some possible combinations of interaction avoidance measures did not specifically appear in any of the alternatives due to impracticality or redundancy, and these were, in effect, alternatives considered but eliminated from detailed study.

The alternatives analyzed in this EIS focus on cost-effectively reducing the harmful effects of seabird interactions in the Hawaii-based longline fishery. Alternatives to impose measures on General Longline Permit holders were considered, but eliminated from detailed study. Vessels authorized to fish under General Longline Permits are prohibited from fishing in EEZ waters around Hawaii or landing any fish in Hawaii. They might tranship catches into Hawaii, but this has never happened in the history of the Hawaii fishery due to the economics of running two vessels to land one vessel's catch (Sean Martin, President HLA, pers. comm.).

Alternatives to impose measures on longline vessels based in California but not registered to Hawaii limited entry permits were not considered, as the Council does not have jurisdiction over these vessels, which are prohibited from fishing in EEZ waters around Hawaii or landing any fish in Hawaii.

Other seabird interaction avoidance measures have been informally tested by fishermen (weighted hooks, towed trash bags, avoidance of setting in the vessel's wake, undyed thawed bait) and at least one, the bait-setting capsule, has been developed and tested as a prototype. Noise making, either with explosive devices or horns, has been shown to be ineffective. None of these measures, however, were considered by the Council in formulating its proposed action. None of these could be expected to have benefits of a different nature or greater magnitude than those evaluated here. Further, none of them have been tested in the Hawaii-based longline fishery, and their efficacies are unknown. Consequently, these measures were eliminated from detailed study.

Other types of hooks and baits could eventually prove useful in mitigating seabird interactions. At this time, however, regulations specifying hook and bait type in the shallow-set sector of the fishery are rooted in experiments conducted in the Atlantic Ocean which dramatically reduced interactions with leatherback and loggerhead sea turtles. Any other combination of hook and bait proposed to reduce seabird interactions would first have to be tested for efficacy in deterring interactions with sea turtles, and therefore, variations of hook or bait types were eliminated from detailed study.

Many of the alternatives considered here are paired, with one alternative employing seabird interaction avoidance measures only at latitudes north of 23°N latitude and the other employing interaction avoidance measures wherever fishing is done. The current southern boundary for implementation of seabird interaction avoidance measures in the Hawaii-based fleet is 23°N latitude. The original rationale for that selection was to protect short-tailed albatross, because that is the lowest latitude at which a short-tailed albatross has ever been seen near Hawaii. The objective of this action however, is to cost-effectively reduce the harmful effects of all seabird captures by the fleet, so a reexamination of the rationale for this boundary is appropriate.

There exist an infinite number of potential geographic variations of where seabird interaction avoidance measures might be mandated, including latitudes above and below 23°N latitude, various sizes and shapes of polygons, etc. To determine if there appears to be a need to expand the area in which seabird interaction avoidance measures are required, Table 2.1-7 uses historic data from the Hawaii longline fleet to calculate the numbers of sets, trips and years between seabird interactions with tuna and swordfish vessels above and below 23°N latitude, gathered from the time before NMFS imposed seabird avoidance measures.

Table 2.1-7 Seabird Interactions Without Avoidance Measures by Type of Set, Trip and Year for Hawaii Longline Vessels Fishing South and North of 23°N.

Area/Type of Set	Interactions per Set	Sets per Interaction	Sets per Trip	Trips per Interaction	Trips per Year	Years per Interaction
North/Deep	0.07016	14	11.1	1.28	12.40	0.10
South/Deep	0.00799	125	11.1	11.28	12.40	0.91
North/Shallow	0.54583	2	14.6	0.13	3.14	0.04
South/Shallow	0.01650	61	14.6	4.15	3.14	1.32

Sources: M. McCracken Memo of 10/15/04 for interactions per set; WPRFMC 2004a.

Interaction rates for shallow sets come from the 1994-1999 time period as shallow-setting was prohibited between 2000 and 2004. Interaction rates for deep sets in the north are also from the 1994-1999 time period as regulatory changes, including the imposition of seabird interaction avoidance measures, were mandated for deep sets in this area beginning in 2000. Operating information (average sets per trip and trips per year) for these groups is from the 1994-1998 time period as regulatory changes at the end of 1999 restricted shallow-setting. Information for deep sets in the south is from the 2002-2003 time period, as no avoidance measures have been imposed for the south and it is preferable to use the most recent data available. Operating information for deep sets comes from the second quarter of 2004 as this most recent information best describes current operating conditions.

The Preferred Alternative for the seabird action objective recommended in this EIS will mandate the use of seabird interaction avoidance measures in shallow-north, shallow-south and deep-north sets. Only deep-south sets would not be required to employ seabird interaction avoidance measures. The most recent effort data from the fleet (NMFS PIRO unpub. data) shows that of the 121 tuna (deep-setting) vessels, 111 fished above 23°N latitude at least once during the year. If this pattern persisted in the future, only 10 vessels would employ no seabird interaction avoidance measures at any time during the year. Of the vessels fishing north of 23°N latitude, it is projected (see Section 4.5) that 95% would ultimately convert to side-setting. Once converted, these vessels would employ side-setting whether fishing north or south of 23°N latitude. The remaining 5% of the 111 vessels, about six vessels, would not be required to employ seabird interaction avoidance measures when fishing below 23°N latitude. These six vessels plus the 10 vessels fishing exclusively south of 23°N latitude would be the only vessels in the fleet not using seabird interaction avoidance measures south of 23°N latitude. The annual interaction rate for deep-south sets is 0.00799 interactions per set (Table 2.1-7). If tuna vessels make 12.4 trips per year and average 11.1 sets per trip, the total number of interactions from this subset of the fleet will be 1.1 birds per year. It is anticipated that a loss of one bird per year is not expected to have a significant effect on the population trajectory of either Laysan or black-footed albatrosses. However, the impact of fishery-related mortality on Laysan or black-footed albatrosses is under study (H. Freifeld, USFWS, e-mail to A. Clemens, NMFS, April 15, 2005). Lacking the results of this study, the 23°N latitude boundary for imposition of seabird interaction avoidance measures is considered precautionary at this time. If we consider implementation of seabird interaction avoidance measures in the fleet as an experiment that will generate realistic seabird interaction rate data for vessels using either side-setting or a suite of independent seabird interaction avoidance measures, and if variation in abundance are great enough to register in observer data, there may be some value to maintaining this small group of vessels not using seabird interaction avoidance measures as a control to account for such things as year-to-year variability in seabird abundance.

Another category of potential alternatives is time and/or area closures. The Hawaii-based longline fleet is currently subject to area closures around the NWHI and the MHI, the former especially important in prohibiting longlining near seabird nesting areas. Alternatives incorporating additional time and area closures were considered but were eliminated from detailed study. The paragraphs below summarize seasonable variability in seabird capture in the Hawaii-based longline fishery, and provide rationale for elimination of these types of operational controls on the fleet from further study.

Seabird captures by the Hawaii-based longline fleet are characterized by strong seasonal variability. NMFS's annual report on seabird interactions in the longline fishery (NMFS 2004c) summarizes the 2003 interactions by calendar quarter as shown in Table 2.1-8. Shallow-setting was prohibited during this time, so these data are from deep sets only. Nevertheless, the seasonality of interactions is quite apparent.

Table 2.1-8 Estimated Numbers of Interactions with Black-footed and Laysan Albatross by Hawaii-based Longline Vessels by Calendar Quarter for 2003.

Species	Estimated Numbers of Interactions per Quarter				Total Interactions
	Quarter 1	Quarter 2	Quarter 3	Quarter 4	
Black-footed	28	76	7	0	111
95% Confidence Interval (CI)	6-58	36-114	1-27	0-12	
Laysan	28	118	0	0	146
95% CI	6-58	71-161	0-16	0-12	

Source: NMFS 2004c.

Cousins and Cooper (2000) summarize the reproductive biology of the black-footed albatross as follows. Black-footed albatross lay their eggs in mid-November to early December. The mean incubation period is 65.6 days, during which time the adults forage close to the breeding colony. The chick hatches between mid-January and early February, and a brooding period lasting one to two weeks ensues. During this period, at least one parent stays with the chick. The adults forage close to the breeding colony during this period as well, but subsequently begin to take longer trips of two to three weeks. First quarter interactions are markedly lower than second quarter interactions and this may reflect the fact that adults are feeding very close to the colony during the first quarter, perhaps predominantly within the area around the NWHI closed to longline fishing. Fledging takes place in late July. Adults spend the remainder of the year dispersed over the northern Pacific Ocean. Non-breeders and failed breeders leave the colony earlier, in April. The Laysan albatross breeding schedule is similar to that of the black-footed albatross. Given this seasonality of breeding colony occupation, it's clear why the observed albatross interactions are so heavily concentrated in the first half of the year.

Seasonality in swordfish effort corresponds with the seasonality of seabird abundance in the NWHI. The Hawaii-based shallow-set effort is strongly seasonal, with the greatest effort concentrated in the first half of the year. This is brought about by annual cycles of oceanographic conditions. In the summer and fall, water temperatures favorable for swordfish fishing are found far to the north. At those latitudes, trips are long, fuel costs are high, weather can be unpredictable and dangerous, and product quality can suffer. In the winter and spring, cooler water is closer to Hawaii and trips are shorter, safer and more economical. This is why Hawaii-based swordfish effort is concentrated during the first half of the year at lower latitudes. Effort limitations during that period could severely impact the economics of the fleet. Given the objective of this action (the cost-effective reduction of the effects of the Hawaii-based longline fishery on seabirds), the status of potentially affected seabird populations (stable to increasing), and the availability of a broad range of effective seabird interaction avoidance measures, time/area closures were not considered in detail.

Effort in the deep-set sector of the fleet tends to move further southward in the winter months, as tuna move south with the warmer waters. A relatively small amount of deep-set effort occurs north of the NWHI during the months when seabirds are occupying their breeding habitat. Since implementation of the currently required seabird interaction avoidance measures in 2000, the annual catch of seabirds by the Hawaii-based longline fleet has been reduced by an order of magnitude (see Table 3.6.1-6 and Figure 3.6.1-5). The Preferred Alternative for the seabird action is expected to reduce that value even further, as an additional seabird interaction avoidance measure will be added to the suite of required measures unless side-setting, which has been shown to virtually eliminate seabird capture, is adopted. At the expected levels of seabird interactions, implementation of new time or area closures does not seem necessary to protect albatross populations in the NWHI.

2.2 Alternatives for Management of the U.S. Pacific Ocean Squid Jigging Fisheries

In consideration of jurisdictional boundaries, the objective has been divided into two sub-objectives and alternatives developed for each.

2.2.1 Alternatives for Management of the Squid Jigging Fisheries under the MSA

This set of alternatives would establish a framework for monitoring and management of the pelagic squid jigging fisheries in the Pacific Ocean under the MSA.

SQA.1 Sub-objective A No Action. Do not use an FMP to monitor or manage squid fishing in areas under the Council's jurisdiction.

SQA.2 Voluntary Monitoring. Improve voluntary monitoring by the optional use of logbooks designed specifically for use by domestic pelagic squid vessels, and by the voluntary placement of federal observers on these vessels. Centralize this data into a database easily available to resource managers. (The Council has reached a preliminary agreement with the three known domestic high seas squid jiggers to voluntarily participate in a pilot program under which they would use modified logbooks and carry federal observers. This alternative would continue these efforts.)

SQA.3 Mandatory Monitoring and Management Through the Pelagics FMP. This is the Preferred Alternative for Sub-objective A. Improve mandatory monitoring and establish a framework for management by including pelagic squid in the Council's existing Pelagics FMP. Replace HSFCA logbooks currently used with logbooks specifically designed for squid harvesting, and require operators of squid vessels permitted under the HSFCA to also include any EEZ fishing activities in this logbook. Require vessels that harvest pelagic squid solely in EEZ waters to either use this logbook or to participate in local reporting systems. Centralize this data into a database easily available to resource managers.

SQA.4 Mandatory Monitoring and Management Through a New Squid FMP. Improve mandatory monitoring and establish a framework for management by developing a new Squid FMP for pelagic squid. Replace HSFCA logbooks currently used with logbooks specifically designed for squid harvesting, and require operators of squid vessels permitted under the HSFCA to also include any EEZ fishing activities in this logbook. Require vessels that harvest pelagic squid solely in EEZ waters to either use this logbook or to participate in local reporting systems. Centralize this data into a database easily available to resource managers.

SQA.5 Mandatory Monitoring and Management Through International Agreement. Improve mandatory international monitoring and establish a framework for both domestic and international management by pursuing and participating in international management agreements for Pacific Ocean pelagic squid. Consider the use of mandatory observers on vessels harvesting squid.

2.2.2 Alternatives for Management of the Squid Jigging Fisheries under the MSA or HSFCA

Under this set of alternatives, the pelagic squid jigging fishery would continue to be managed under the HSFCA or by fishery management councils under the MSA.

SQB.1 Sub-objective B No Action. Continue to implement the HSFCA as it pertains to the high seas domestic squid fishery (i.e., continue to require HSFCA permits and catch reports for these vessels).

SQB.2 Cease Issuing HSFCA Permits. Cease issuing HSFCA permits for the high seas domestic squid fishery (i.e., stop issuing HSFCA permits for domestic squid vessels and do not allow un-permitted vessels to fish on the high seas).

SQB.3 Voluntary Monitoring. Improve voluntary monitoring by the optional use of logbooks designed specifically for use by domestic pelagic squid vessels, and by the voluntary placement of federal observers on these vessels. (The Council has reached a preliminary agreement with the three known domestic high seas squid jiggers to voluntarily participate in a pilot program under which they would use modified logbooks and carry federal observers, this alternative would continue these efforts.) Centralize this data into a database easily available to resource managers.

SQB.4 Improved Monitoring and Management Through the HSFCA. This is the Preferred Alternative for Sub-objective B. Improve mandatory monitoring by replacing the HSFCA logbooks currently used with required logbooks specifically designed for squid harvesting. Centralize this data into a database easily available to resource managers. In addition, revise HSFCA permit applications should be revised to indicate the specific fisheries (including both gears and target species) in which permittees anticipate fishing on the high seas (e.g., jigging for pelagic squid).

SQB.5 Improved Monitoring and Management Through FMPs. Establish domestic management mechanisms by categorizing all domestic vessels harvesting squid on the high seas as under the jurisdiction of one or more fishery management councils and asking the relevant council(s) to include pelagic squid in their fishery management plans.

SQB.6 Improved Monitoring and Management Through International Agreement. Improve mandatory international monitoring and establish mechanisms for both domestic and international management by pursuing and participating in international management agreements for Pacific Ocean pelagic squid.

At its 124th meeting, the Council selected Alternative SQA.3 as its Preferred Alternative for Objective A, and Alternative SQB.4 as its Preferred Alternative for Objective B.

2.2.3 Squid Fishery Management Alternatives Considered but Eliminated from Detailed Study

At the present time, U.S. participation in this international fishery is extremely limited, with from 0 to 4 vessels participating in each of the past four years. Hundreds of foreign vessels participate in this fishery. Our current knowledge of the status of the stocks, fishing mortality and bycatch in this fishery is very limited, although the stocks appear healthy and neither bycatch nor protected species interactions (see Section 3.4.5) appear to be a problem. Consequently there does not appear to be any reason at this time to propose management alternatives that would limit fishing mortality or reduce bycatch (such as time or area closures, or effort or landing limits). Also not under current consideration is the use of vessel monitoring systems. These systems monitor the location of fishing vessels and are only appropriate for fisheries that are subject to area closures. However, the establishment of mechanisms to implement specific fishery management measures would allow for regulatory controls to be quickly put in place should resource concerns arise.